Learning to learn for innovation and sustainable development

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A conceptual model
of inter-organizational learning
based on four innovation projects
in the Dutch paper and board producing industry

Learning to learn for innovation and sustainable development

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door

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geboren op 19 januari 1963 te Deurne.

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Preface

When I received my master's degree at the Catholic University Brabant in Tilburg in November 1987, I never imagined that 26 years later I would be back finishing and defending my doctoral thesis at the same institution, now called Tilburg University. So how did that happen?

My first job was with IBM The Netherlands, where I was employed between 1991 and 1999 in the fields of accounting, market research and quality management. During that time I found that in my job I missed a connection with nature, in which I had held a keen interest since I was a kid. I decided to try and shape my career in the direction a profession in which ecological and environmental matters played a role. With the help of the career development group of Axis Management (Jan Pompe) I started to develop myself further, parallel to my work with IBM: I took courses on environmental management and sustainable entrepreneurship (Open University, Free University in Amsterdam). I fulfilled internships with WWF and Provincial Landschappen, and was a member of the Board of the Environmental Center in Amsterdam.

In 1999, when I was orienting myself on a change of jobs, I was offered a position as a consultant with IMSA in Amsterdam where, up until 2003, I contributed to research and stakeholder dialogue projects for multinationals and the paper and board producing industry. Next, from 2003 – 2005, I worked as a senior consultant with BMD, an environmental consultancy firm that serves small and medium-sized companies. My focus was on the waste processing and food sector. In 2005, I set up Trees Inventing, a consultancy firm for innovation and sustainable entrepreneurship.

Fascinated by the innovation possibilities and challenges of complex stakeholder dialogue projects that I observed in some assignments, I hit on the idea of writing a doctoral thesis on innovation and sustainable development in 1999. I did some preliminary research with the help of prof. dr. Jeroen van den Bergh (Free University, Amsterdam) and participated in a PhD-network at the Erasmus University Rotterdam. However, my interests were different to those of Jeroen van den Bergh, and so in 2003 I asked prof. dr. Nigel Roome to be my supervisor.

Nigel has given me priceless guidance and advice over the past 10 years. And since June 2012, prof. dr. Niels Noorderhaven and dr. Tobias Gössling have provided me with valuable suggestions on improving and completing my thesis. Prof. dr. Thomas Dyllick, prof. dr. Pursey Heugens, prof. dr. Jac Geurts and dr. Frank Boons added their voices to the Committee in November 2013 and supported me greatly.

I want to thank all members of the Committee very much for their invaluable guidance and support, and I am sure that in the future I will dearly miss our regular meetings. I would especially like to thank Nigel Roome who has been so patient with me, given my slow progress. I have enjoyed your way of thinking and style of supervising very much, and I am glad that we developed a very amicable relationship over the past few years. I also thank prof. dr. Jeroen van den Bergh, who helped me to find my direction in the very first stages of my research. And I thank the members of the PhD-network, who provided me with critical observations and inspiring examples.

I am grateful to ir. Gerrit Jan Koopman MCM (Director of the Association of Dutch Paper and Board Producing Companies, VNP) and drs. ing. Arie Hooimeijer (Director of the Knowledge Center Paper and Board, KCPK) who helped me greatly in the selection of the cases used and introduced me to a number of directors of paper and board producing companies. I want to thank all of the interviewees from companies A, B and C and the other organizations I approached. You were most gracious with your time and very open and cooperative. Your invaluable contributions formed the basis for the outcomes of this research.

Thanks also to Riet Ooms (Riet Ooms Administrative Support), who transcribed hours and hours of recorded interviews, and to Danny Guinan (Wordforword) who very accurately translated the quotations from the interviews and corrected my English.

I am indebted to dr. Ronald Chavers for his methodological and philosophical suggestions, and for his inspiring ideas and examples. Ronald, you have helped me enormously in my efforts to follow my interests and my intuition, and to maintain a work rate in balance with the other activities in my life. I would also like to thank Jan Pompe (Axis into Management). You helped me to reconnect with my natural strengths, which have been fundamental to my development and to the completion of my research. Your Common Sense Development Program has greatly sharpened my understanding of the innovation processes, and it was at the basis of many of my ideas. In addition to Ronald and Jan, I would also like to thank the other members of the Methodology Group for their support and inspiration: Mayumi Chavers, Gaudia Galama and Olga Eckhardt. I also thank Els Sangers (Inholland University) for her interest, support and enthusiasm, and for our exchange of ideas and experiences.

Last but not least, I am very thankful to my dear wife Evelien for her never-ending support in my scientific endeavors and professional development. I am very grateful for the time and space afforded to me in our family to work on

the thesis, work that took up many long evenings, especially during the holidays in December 2013. And many thanks to Boaz and Sepha for demonstrating to me, time and time again, the natural inclination to question, to imagine, to play, to discover and to create.

I am very grateful to my parents, Wim van Kleef and Ria van Bakel, who raised me and nurtured and trusted my potential. Thank you for helping me to develop a number of important character traits that are at the very basis of my research: curiosity, a broad range of interests, imagination, perseverance, trust and sufficient intellectual possibilities.

Finally, my thoughts go to my forefathers: the blacksmith, the weaver and the sock-maker from Nuenen; the bakers from Monnickendam, Poeldijk and Kethel; and the coal miner from Godów in Poland. Their life histories and talents have been passed on to me and have undoubtedly contributed to my development and research.

Han van Kleef, January 1, 2014

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Summary

This research is based on the observation that innovation to improve sustainable development requires learning on societal, organizational and individual levels. Business practices influence the development of systems of production and consumption, and in order to be able to move towards sustainable development there is a need for innovation in the way businesses learn and innovate.

This research into innovation processes uses case studies of four innovation projects in three companies in the paper and board producing industry in The Netherlands, in companies that differ from each other in markets served, head office location, degree of autonomy, government structure, ownership structure and financing. Initially, I identified critical observations and a research agenda, on the basis of literature research in the fields of innovation, sustainability, (inter-)organizational learning, capability and competence building and dynamic capabilities. Then, three main research questions were formulated:

1. What was the role of managers in the processes of innovation and learning in the projects, and to what extent and in which way did these processes contribute to the development of changes for greater sustainable development?
2. How were the managerial capabilities, the innovation processes, the teams, the network, and the project outcomes related to each other?
3. Which dynamic capabilities for innovation and sustainable development can be distinguished?

The research method that was applied to answer these questions is based on the philosophy that research should contribute to the development of theoretical insights that are firmly rooted in empirical phenomena. It should take into account existing knowledge and support the design of measures that improve business management in practice. Therefore, a combined inductive and deductive approach was applied whose aims were: i) to discover key themes and new insights in the dynamics and social experiences of concrete innovation processes, and ii) to develop theory in the field of organizational learning for innovation and sustainable development.

Through interviews with 28 key participants and through the study of documents, the development histories of the paper industry, the participating companies and the projects were examined. A narrative interview method was used. Multiperspectivistic and developmental pictures of the innovation projects

were created to reconstruct the dynamics of the learning and innovation processes. These reconstructions were analyzed and compared with each other to answer the research questions.

In the analysis, three main aspects of innovation projects were identified. First, the development of innovation processes, in which processes of problem and concept development, research and testing, design, and implementation could be distinguished. Secondly, the development of inter-organizational learning systems in which different actors cooperated to realize innovation processes and develop capabilities and competences. This aspect includes the actors, the processes through which new actors were involved and meeting structures were improved, and the informal and formal meetings. And thirdly, the development of capabilities that enabled the innovation processes and the management of learning systems. The personal nature and character of managers, their cultures, work experiences and educations are part of this aspect. On the basis of these three aspects and their developments, a conceptual model was built demonstrating the dynamics of inter-organizational learning for innovation that had occurred.

Cross-case analyses brought to light the characteristics of innovation projects that had stimulated both management satisfaction and broader learning among the actors. These were: management focus on the improvement of inter-organizational learning systems and the participation of managers in a wide range of innovation processes; management focus on communication for common understanding, joint decision-making, the prevention of escalation of tensions, and facilitation of the social reconstruction of issues as a basis for the social construction of innovations; senior managers with a sustainability philosophy and a systems view; the involvement of internal and external actors in economic, social and environmental networks who were related to the issues; the application by managers of technical capabilities, methods and philosophies to understand and partake in the innovation processes; and, the complementarity of the capabilities, methods and philosophies for innovation and learning system development that were applied on a team level.

The research findings were compared to the research of other scholars, and this showed that my research differs in several aspects. It models the dynamics and interrelationships of the main aspects that influenced the development of (inter)organizational learning and innovation in a way that enables one to systematically picture, preview and manage the empirical development of an innovation project and of a dynamic capability for sustainable development. It clarifies how the development of management contributions and capabilities was related to the development of learning

structures and innovation processes. It highlights specific factors that influenced the development of management capabilities, and it explicitly supports the need for more democratic business models. Compared to authors who in the 1960s and 70s laid the groundwork for the concept of systems change and sustainable development, this research especially contributes insights and methodical suggestions for dealing systematically with empirical wicked problems, messes, and domain-related meta-problems.

The conclusions of the research offer theoretical propositions that relate to learning to learn for innovation and sustainable development in an inter-organizational system. They cover what according to the research are considered to be the most important aspects of this process. They must been seen from the point of view that generalization of the outcomes of the research to other projects or companies is only possible after analysis has demonstrated that the aspects, influential factors and developments in these projects are comparable with the ones brought forward in this research.

First, learning for innovation and sustainable development, and also levels of management satisfaction, are improved when a team consists of actors from the economic, social and ecological networks, when it invests in learning from the past and when it applies joint decision-making. A focus by actors from the economic, social and ecological networks on a social reconstruction of the histories and backgrounds of issues promotes insight into the roots of issues and builds common understanding in a team. Thus, a basis is developed for the social construction of goals that are appropriate, understood and accepted, and of innovations that contribute to sustainable development.

The participation in a learning system of actors from the social and ecological networks, with interests, cultures and views that differ from those of economic actors, highlights the hidden aspects of various issues. This naturally promotes discussion and arguments that tend to block the sharing and recombining of ideas, knowledge and experience if one actor is dominant and tries to enforce a decision. Joint decision-making procedures stimulate actors to continue the discussions and to keep contributing to a project. This results in deeper and wider learning, a better fit between innovations and issues, and greater management satisfaction than in the case of a less diverse learning system in which decisions are forced upon actors.

Secondly, the potential for learning, innovation and management satisfaction increases if teams are guided by experienced senior managers with specific strengths in inter-organizational learning system development. The diversity of the actors and the quality of the meetings that form the structures of inter-organizational learning systems in which they meet, argue, discuss,

cooperate and learn define the potential for management satisfaction and learning. The guidance provided by experienced senior managers with specific capabilities, methods and philosophies in the fields of systems thinking, networking, communication and development improves this quality.

And lastly, enduring practice in dealing with the complexity of social issues and the dynamics of the different aspects of innovation projects needs to accompany the study of theory on learning for innovation and sustainable development if an organization wishes to develop the related organizational competence. The development of this competence entails a new journey in learning and development: companies and other actors need to learn how to learn with others and from the past. It takes time and practical experiences in messy, daily practice to develop insights and trust in the dynamic, multi-sided learning processes for innovation and sustainable development. Self-discipline and careful reflection are needed to learn to deal with arguments and tensions in a positive way and to trust their logic and usefulness. And patience must be cultivated to persist through the ups and downs, to deal with complex issues and insecurity, to develop trust among the actors, and to gradually develop a new innovation culture together. The integration and alignment of management theories and practices for innovation and sustainable development into organizational competencies is facilitated by team coaching in relation to actual issues and projects.

Company managers are advised to learn to accept complexity and to research the different economic, ecological and social dimensions of an issue; to evaluate, extend and improve the involved learning system, especially formal meetings, policies and working methods; to develop capabilities and procedures for the reconstruction of the histories and backgrounds of issues, and for joint decision-making; to evaluate the philosophy, methods and capabilities applied by the team managing the resolution of the issue, and to make sure that complementarity between them is created; and to engage and train experienced senior managers for the guidance of innovation teams.

Policy makers are advised to translate societal issues into issues for companies and for the systems they function by. It is recommended that they participate actively in innovation projects; develop multi-actor platforms geared towards learning and innovation under conditions of diversity and joint decision-making; and, design laws that create conditions that challenge businesses to innovate in ways that contribute to system change towards greater sustainable development. To be effective in this endeavor, government representatives must also learn to analyze and reconstruct issues with a team; to communicate in informal meetings and formal platforms in order to create common

understanding with culturally diverse actors; to prevent the escalation of arguments; to guide groups in a participative way with joint decision-making; and to develop an orientation that focuses more on realizing team-learning processes than goals.

Samenvatting

Dit onderzoek is gebaseerd op de observatie dat leren nodig is op de niveaus van maatschappij, organisaties en individuen, om innovaties te laten bijdragen aan duurzame ontwikkeling. Ontwikkelingen in bedrijven beïnvloeden onze systemen van productie en consumptie. Het is nodig dat bedrijven hun manieren van leren en innoveren vernieuwen om vooruitgang te boeken in de richting van duurzame ontwikkeling.

Dit onderzoek naar innovatieprocessen gebruikt casestudies van vier innovatieprojecten in drie bedrijven in de Nederlandse papiersector. De bedrijven hebben een verschillende marktfocus, locatie van het hoofdkantoor, mate van zelfstandigheid, bestuurs- en eigendomstructuur en financiering. Op basis van literatuuronderzoek op het gebied van innovatie, duurzaamheid, leren van organisaties, managementvaardigheden en organisatiecompetenties heb ik kritische kanttekeningen geplaatst bij de bestaande theorieën. Daarna heb ik een onderzoeksagenda geformuleerd waaruit de drie onderzoeksvragen zijn voortgekomen.

1. Wat was de rol van managers in de innovatie- en leerprocessen in de onderzochte projecten? In welke mate, en hoe, hebben deze processen bijgedragen aan het ontwikkelen van veranderingen voor duurzame ontwikkeling?
2. Wat waren binnen de projecten de verbanden tussen de managementvaardigheden, de innovatieprocessen, de teams, de netwerken en de uitkomsten?
3. Welke dynamische organisatiecompetenties voor innovatie en duurzame ontwikkeling kunnen worden onderscheiden?

De onderzoeksmethode die ik heb toegepast bij het beantwoorden van deze vragen is gebaseerd op de visie dat onderzoek moet bijdragen aan theoretische inzichten die stevig in empirische verschijnselen geworteld zijn. Ook moet onderzoek rekening houden met bestaande kennis en inzichten, en bijdragen aan maatregelen die bedrijfsmanagement in de praktijk verbeteren. Daarom heb ik een gecombineerde inductieve en deductieve benadering toegepast, met als doel: i) de belangrijkste thema’s en nieuwe inzichten te ontdekken in de dynamiek en sociale ervaringen in innovatieprocessen, en ii) theorie te ontwikkelen op het gebied van het leren van organisaties voor innovatie en duurzame ontwikkeling.

Ik heb de geschiedenissen van de sector, de deelnemende bedrijven en de projecten onderzocht door 28 sleutelfiguren te interviewen en door documentatie te bestuderen. Ik heb een interviewmethode gebruikt die een geïnterviewde zoveel mogelijk ruimte geeft om zijn eigen verhaal te vertellen. Op basis van de interviewgegevens kon ik de ontwikkeling van ieder project reconstrueren vanuit verschillende perspectieven, inclusief de dynamiek van de leer- en innovatieprocessen. Deze reconstructies heb ik geanalyseerd en met elkaar vergeleken om de onderzoeksvragen te beantwoorden.

In de analyse heb ik de drie belangrijkste aspecten van de innovatieprojecten kunnen identificeren. Ten eerste de ontwikkeling van innovatieprocessen. Hierbinnen konden worden onderscheiden: probleem- en conceptontwikkeling, onderzoek en testen, ontwerp en implementatie. Ten tweede de ontwikkeling van leersystemen waarin verschillende actoren samenwerkten om innovatieprocessen te realiseren en vaardigheden en organisatiecompetenties te ontwikkelen. Dit aspect omvat de actoren, de processen waarmee nieuwe actoren betrokken werden en vergaderstructuren verbeterd werden, en de verschillende vormen van overleg. En ten derde de ontwikkeling van managementvaardigheden die de innovatieprocessen en het inrichten van de leersystemen mogelijk maakten. De karakters van de betrokken managers, de culturen waar ze uit voort komen en deel van uit maken, hun werkervaringen en opleidingen maken deel uit van dit aspect. Op basis van deze drie aspecten heb ik een conceptueel model gebouwd dat de dynamiek duidelijk maakt van de leerprocessen in de projecten.

Een vergelijkende analyse van de casestudies maakte duidelijk welke projectkenmerken zowel de tevredenheid van het management hadden bevorderd alsook het aantal actoren met een leerervaring hadden vergroot. Deze kenmerken waren de volgende: managementaandacht die vooral gericht was op de verbetering van leersystemen tussen organisaties. De deelname van managers aan een breed scala van innovatieprocessen. Managementaandacht voor het bevorderen van gemeenschappelijk begrip tussen de actoren. Gezamenlijke besluitvorming. Het voorkómen van de escalatie van spanningen. Het gezamenlijk reconstrueren van de oorsprong van vraagstukken, als basis voor het ontwikkelen van vernieuwingen. De deelname van senior managers met een duurzaamheidsfilosofie en een systeemvisie. De betrokkenheid van interne en externe actoren, afkomstig uit economische, sociale en ecologische netwerken, met een relatie tot de knelpunten. De inzet van technische vaardigheden, methoden en zienswijzen die managers in staat stelden om de innovatieprocessen te begrijpen en er aan deel te nemen. En vaardigheden, methoden en zienswijzen die elkaar op teamniveau aanvulden met betrekking tot de innovatieprocessen en leersystemen.

Ik heb de bevindingen uit het onderzoek vergeleken met het werk van andere onderzoekers, en zo werd duidelijk waarin mijn onderzoek onderscheidend is. Het modelleert de dynamiek en onderlinge verbanden tussen de belangrijkste aspecten die de ontwikkeling van leren en innoveren beïnvloedden. Het doet dit op een manier die een manager in staat stelt om zich de ontwikkeling van een innovatieproject en een dynamische competentie voor duurzame ontwikkeling systematisch voor te stellen, te voorzien en te sturen. Mijn onderzoek verheldert hoe de ontwikkeling van managementbijdragen en vaardigheden verbonden was met de ontwikkeling van innovatieprocessen en organisatiestructuren. Het belicht factoren die de ontwikkeling van managementvaardigheden beïnvloedden, en het maakt de behoefte duidelijk aan meer democratische manieren van bedrijfsvoering. In vergelijking met de auteurs die in de jaren 60 en 70 van de twintigste eeuw de basis legden voor de concepten systeemverandering en duurzame ontwikkeling, draagt dit onderzoek vooral inzichten en methodische suggesties bij voor het systematisch hanteren van ondoorzichtige praktijkvraagstukken waarin sprake is van veel verschillende actoren, gebrek aan sturing, onduidelijke oplossingsrichtingen en ongedefinieerde criteria voor de eindsituatie.

De conclusies uit het onderzoek bieden theoretische suggesties voor het vormgeven van leerprocessen voor innovatie en duurzame ontwikkeling, in samenwerking tussen meerdere organisaties. De conclusies bestrijken de aspecten die volgens dit onderzoek de belangrijkste zijn van een dergelijk proces. Ze moeten gezien worden vanuit het gezichtspunt dat generalisering van de uitkomsten naar andere projecten of bedrijven alleen mogelijk is nadat een analyse heeft aangetoond dat de aspecten, invloedrijke factoren en ontwikkelingen in deze projecten vergelijkbaar zijn met wat in dit onderzoek naar voren is gebracht.

Ten eerste worden leerprocessen voor innovatie en duurzame ontwikkeling, en ook de tevredenheid van het management, verbeterd als een team bestaat uit deelnemers uit de economische, sociale en ecologische netwerken, als het investeert in het leren van het verleden, en als het gezamenlijke besluitvorming toepast. Als deelnemers uit economische, sociale en ecologische netwerken zich richten op de gezamenlijke reconstructie van de achtergronden van een vraagstuk, dan bevordert dat inzicht in de wortels van dat vraagstuk en ook een gemeenschappelijk begrip in een team. Zodoende ontwikkelt een team een basis voor de gemeenschappelijke constructie van passende, begrepen en geaccepteerde doelstellingen, en van innovaties die bijdragen aan duurzame ontwikkeling.

De deelname in een leersysteem van actoren uit sociale en ecologische netwerken, met belangen, culturen en gezichtspunten die verschillen van de economische actoren, brengt verborgen kanten van vraagstukken aan het licht. Dit bevordert discussies en ruzies die het delen en combineren van ideeën, kennis en ervaring belemmeren als één actor dominant is en een beslissing probeert te forceren. Procedures voor gezamenlijke besluitvorming stimuleren de deelnemers om de discussie voor te zetten en te blijven bijdragen aan een project. Dit mondt uit in een diepere leerervaring, een betere aansluiting van innovaties op knelpunten, en grotere tevredenheid van het management dan in het geval van een minder divers leersysteem waarin beslissingen aan actoren worden opgelegd.

Ten tweede neemt het potentieel voor leren, innoveren en managementtevredenheid toe als teams worden geleid door ervaren senior managers met specifieke kwaliteiten voor het ontwikkelen van leersystemen tussen organisaties. De diversiteit van de actoren en de kwaliteit van de vergaderingen (die de structuren vormen waarbinnen actoren elkaar ontmoeten, ruziën, discussiëren, samenwerken en leren) bepalen het potentieel voor managementtevredenheid en leren. Leiding door ervaren senior managers met vaardigheden, methoden en filosofieën op het gebied van systeemdenken, netwerken, communicatie en ontwikkeling, verbetert deze kwaliteit.

Tenslotte zal, als een organisatie wil kunnen leren voor innovatie en duurzame ontwikkeling, het bestuderen van theorie moeten samengaan met voortdurende oefening in de praktijk. Het ontwikkelen van die competentie vraagt om een nieuwe aanpak op het gebied van leren en ontwikkelen. Bedrijven en andere actoren moeten leren hoe ze met anderen kunnen leren van het verleden. Voldoende tijd en praktijkervaringen in de rommelige dagelijkse werkelijkheid zijn nodig om inzicht en vertrouwen te ontwikkelen in dynamische, veelzijdige leerprocessen voor innovatie en duurzame ontwikkeling. Zelfdiscipline en zorgvuldige reflectie zijn nodig om op een positieve manier te leren omgaan met ruzies en spanningen, en om hun logica en bijdrage te leren vertrouwen. Geduld is nodig om ondanks ups en downs vol te houden, complexe vraagstukken en onzekerheid te leren hanteren, onderling vertrouwen te ontwikkelen, en geleidelijk aan samen een nieuwe innovatiecultuur te ontwikkelen. De integratie van managementtheorieën en –praktijken voor innovatie en duurzame ontwikkeling in organisatiecompetenties wordt bevorderd door teamcoaching bij het werken aan concrete knelpunten en projecten.

In vervolg op deze conclusies wordt managers geadviseerd om complexiteit te leren accepteren en de diverse economische, sociale en technische dimensies van en vraagstuk te onderzoeken. Om het gebruikte leersysteem te evalueren, uit te breiden en te verbeteren (met vooral aandacht voor de vergaderingen, het beleid en de werkmethoden). Om vaardigheden en werkwijzen te ontwikkelen voor de reconstructie van de geschiedenissen en achtergronden van vraagstukken, en voor gezamenlijke besluitvorming. Om de filosofie, methoden en vaardigheden te evalueren van een team dat zich met een vraagstuk bezig houdt, en ervoor te zorgen dat ze complementair zijn aan elkaar. En om ervaren senior managers te trainen voor het begeleiden van innovatieteams.

Beleidsmakers wordt geadviseerd om maatschappelijke vraagstukken te vertalen in vraagstukken voor bedrijven en voor de systemen waarin die functioneren. Om actief deel te nemen aan innovatieprojecten. Om platforms te ontwikkelen waar meerdere actoren aan deelnemen en die gericht zijn op leren innoveren onder diversiteit en gezamenlijke besluitvorming. En om wetten te ontwerpen die bedrijven uitdagen om te innoveren op manieren die bijdragen aan systeemverandering in de richting van duurzame ontwikkeling. Een voorwaarde voor succes is dat ook de betrokken ambtenaren leren om vraagstukken met een team te analyseren en te reconstrueren. Om in informele bijeenkomsten en formele platforms te communiceren om gemeenschappelijk begrip tot stand te brengen, met actoren die cultureel verschillen van elkaar. Om de escalatie van spanningen te voorkomen. Om groepen te leiden op een manier die deelname en gezamenlijke besluitvorming stimuleert. En om een oriëntatie te ontwikkelen die meer gericht is op het realiseren van de processen van teamleren dan van doelstellingen.

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1 Introduction. Sustainable development in our present situation, and its history. Focus of the research

This introduction is meant to provide a picture of the historical context of my research and the questions that I see as relevant to the task of realizing sustainable development. Here, I will present the general problem description upon which my research is based and introduce the structure of the thesis.

1.1 Innovation and development in the 20th century and their effects

Over the last 100 years, systems of production have gone through major changes. For example, industrialization and mechanization had a profound effect on transport systems and production processes. The scale and speed of manufacturing operations increased dramatically, as did the use of fossil fuels and other natural resources. The invention of telephone, radio and the computer increased the speed and the scale of business. The chemical sector developed new materials and substances. Agricultural companies increased their scale and started using chemicals. In the second half of the 20th century, the development of the ICT sector resulted in a huge increase in the amount of information on and available to business processes and markets. Digitalization led to new production techniques and a range of new products. Business went global.

These developments, often spurred by technological innovations, have changed our patterns of consumption and production and have had very diverse effects on local and global economies, on ecological systems, and on international and social relations. The wealth of many countries has increased substantially. Standards of living, comfort, mobility, schooling, emancipation, food security, health care and life expectancy have improved, and social systems prevent the worst cases of poverty in more advanced countries.

However, there were also negative effects. Many studies have indicated imbalances between economic developments on the one side and social, health and ecological developments on the other (Carson, 1964; Meadows et al, 1972; Ackoff, 1974). The result of these studies has been the development of the concept of systems thinking (Ashby, 1962; Von Bertalanffy, 1968; Beer, 1972; Meadows et al., 1972; Ackoff, 1974; Boulding, 1996), and the strengthening of movements among companies, scientists and policy makers calling our attention to the issue of sustainable development. In 1980, the UNEP, WWF and IUCN published the World Conservation Strategy (IUCN, 1980), coining the term sustainable development and linking environmental with economic and development issues. This culminated in the publication of the report 'Our Common Future' by the World Commission on Environment and Development (Brundtland, 1987).

Acknowledging the risks of current patterns of production and consumption for the environment and human well being, authors in various sciences (e.g. economics, ecology, biology and physics) have formulated alternative views on economic science and the suppositions it makes use of, for example environmental economics, ecological economics and the cradle-to-cradle philosophy. Evaluating the efforts to integrate social, ecological and economic values, it may be said that authors struggle to combine, on the one hand, the supposed wants and needs of an abstract homo economicus (who is said to strive for the maximization of his own profits and utility and whose world view has colored our concept of economy and economic science) and, on the other hand, the wants and needs of real individuals and communities that also go beyond self-interest and take into account common ecological and social values and needs.

1.2 Initiatives by international bodies. Conferences and reports on sustainable development

Parallel to the above-mentioned (scientific) studies and reports, several international initiatives have also been taken to discuss negative environmental and social developments and to find common ground for action towards sustainable development. The first in a series of conferences was the Brundtland Commission (UNWCED), set up in 1983 by the UN. In its report, 'Our Common Future' (Brundtland, G-H., 1987), the commission concludes that multilateral solutions are needed, which demand coordinated political action and responsibility. It sees the earth and human society as a system of interdependent parts that have started to produce different and interlocked crises: an environmental crisis, a development crisis, and an energy crisis. The commission concludes that the international community needs to work on sustainable development, which it has defined as: a way of *"(…) development that meets the needs of the present without compromising the ability of future generations to meet their own needs."* In 1988, the Intergovernmental Panel on Climate Change (IPCC) was established by the World Meteorological

Organization (WMO) and the United Nations Environment Programme (UNEP) as a scientific, intergovernmental body whose aim was to provide policy makers with an *“(…) objective source of information about the causes of climate change, its potential environmental and socio-economic consequences and the adaptation and mitigation options to respond to it” (Intergovernmental Panel on Climate Change, 2008a).* In 1989, the UN began developing Agenda 21, a program of objectives and activities that *“addresses the pressing problems of today and also aims at preparing the world for the challenges of the next century”* (United Nations Department of Economic and Social Affairs, 1992). At the Rio Summit in 1992, the Business Council for Sustainable Development was established with the aim of involving business in sustainable development issues. After merging with the World Industry Council for the Environment in 1995, the World Business Council on Sustainable Development was created. In 2002, the World Summit on Sustainable Development (WSSD) took place in Johannesburg, South Africa. The same year, the European Parliament and the Council adopted The Sixth Environment Action Programme (EAP) of the European Community 2002-2012. Between 2002 and 2014, several international conferences, forums and sessions related to sustainable development were organized, e.g.:

- Commission on Sustainable Development (CSD), 2004, New York
- International Scientific Conference “Biodiversity: Science and Governance”, 2005, Paris
- Commission for Social Development, 2006, New York
- United Nations Forum on forests, 2006, New York
- World Water Forum, 2006, New York
- World Urban Forum, 2006, Vancouver
- United Nations Climate Change Conference, 2006, Nairobi
- 60th Annual DPI/NGO Conference "Climate Change: How It Impacts Us All", 2007, New York
- High-Level Meeting "The Future in our Hands: Addressing the Leadership Challenge of Climate Change", 2007, New York
- United Nations Climate Change Conference, 2007, Bali
- Business For the Environment Global summit, 2008, Singapore
- United Nations Climate Change Conference, 2009, Copenhagen
- United Nations Climate Change Conference, 2011, Durban
- Environment and Health – Bridging South, North, East and West, 2013, Basel

1.3 Reported progress towards sustainable development. General problem description

The overview above demonstrates that, since the 1960s, the attention paid by policy makers and scientists to ecosystem degradation and the negative social effects of economic development has grown steadily. However, status reports repeatedly illustrate that over the past twenty years, although some progress has been made in some areas, unsustainable trends in the patterns of our systems of production and consumption have not markedly changed. (United Nations General Assembly, 1997a; The Millennium Ecosystem Assessment, 2005; World Resources Institute, 2005; WWF, 2006; Intergovernmental Panel on Climate Change, 2008b; Commission of the European Communities, 2007; WWF, 2012; WWF, 2013; Intergovernmental Panel on Climate Change, 2013). This suggests that the policies, action plans and alternative economic models and theories developed so far have, in practice, not yet been able to widely and consistently decrease environmental pressures and prevent damage to health and social systems. Due to the complex nature of our systems of production and consumption and the great number of different actors involved, it is not possible to point to one main cause for this lack of effectiveness. Indeed, in their analyses and recommendations scientists and international organizations suggest different kinds of changes to business, economic science and government policies that are needed to promote more sustainable patterns of production and consumption, for example:

- Economics should widen its working field and include the natural environment and social systems (United Nations General Assembly, 1983; Georgescu-Roegen, 1971; Kapp, 1950; Schumacher, 1973; Herman Daly, 1996a; Boulding, 1966; Holling, 1973; Odum, 1971; Costanza, 1991)
- Working from a systems view implies that both national and international action should be taken, and on “political, economic, social, production, technological, international and administrative levels” (WCED, 1987).
- Conventional economics should modify its view that organizations and individuals exclusively strive for profit and utility maximization, as well as its preference for quantitative and monetary values (Daly et al., 1996b; George, 1932).

Furthermore, changes in methods have also been suggested that can be used to give form to processes of change, for example:

- The concrete goals and instruments of the concept of sustainable development should be formed in discussions between all parties involved (Sharma, 2003). Collaboration in networks and alliances of firms, citizens, governments and NGOs contributes to the practical realization of sustainable development (Sharma, 2002).
- Multidisciplinary platforms and research and development methods are needed to ensure the incorporation of ecological and social aspects next to economic criteria in analyses and improvement trajectories (Costanza et al., 1991; Barbier et al., 1995; World Business Council on Sustainable Development, 2008).
- Organizational structures and work methods should be designed to improve participation of diverse stakeholders in research and development trajectories and to define shared perceptions of long-term environmental issues (United Nations General Assembly, 1983; Costanza, 1991). Partnerships are an important tool for implementing sustainable development (Van Huijstee et al, 2007).
- Work methods should be designed to improve international cooperation and cooperation between countries at different stages of economic and social development (United Nations General Assembly, 1983; United Nations Department of Economic and Social Affairs, 1992)

Also, changes in instruments used to produce desired results in practice have been suggested, for example:

- Common environmental resources and sinks that are currently not priced should be brought into market structures, and tax reforms and legal instruments should discourage resource use (Perman, Ma, and McGilvray, 1996; United Nations Framework Convention on Climate Change, 1997b; Von Weizsäcker, Lovins and Lovins, 1998).
- Innovation is needed to promote the improvements in efficiency and effectiveness that enable a substantial reduction of the environmental impacts of our systems of production and consumption (European Commission, 2001). A firm’s capacity to collaborate and innovate for sustainable development while maintaining its competitiveness is regarded as a specific organizational competence (WCED, 1987; Von Weizsäcker, Lovins and Lovins, 1998).
- Education and capacity building should be directed at bringing forth researchers who are able to design new ways to deal with sustainable development problems in practice and to strengthen the participation

of major groups (WCED, 1987; United Nations Department of Economic and Social Affairs, 1992)

The suggested changes are seen as outcomes of the cooperative efforts of different actors in learning processes that have a social constructionist character. The suggested changes are new, according to the scientists and organizations who put forward these suggestions, and they are expected to create value in the economy, environment and social systems. They do not presently occur in a systematic (in the sense of methodical, deliberate, planned, premeditated) way and on a scale that is sufficiently large enough to effect sustainable development on a global scale, and they require creativity and innovation to be realized on that scale. Sustainable development cannot happen without innovation (Dasgupta and Gupta, 2009). Innovation and learning processes are closely interwoven (Høyrup, 2012) and organizational learning needs to be a key element in efforts to effectively implement sustainable development in corporations (Siebenhüner and Arnold, 2007). Because of the system character of production and consumption processes, I conclude that the innovation processes aimed at improving sustainable development require learning on societal, organizational and individual levels. And the lack of concrete progress indicates that it is essential that society learns how to systematically give form to these learning processes.

1.4 Selected focus of this thesis

Business influences the development of systems of production and consumption through its capacity for technological development and innovation. In order to move faster towards a more sustainable way of development, there may be a need for innovation in the way businesses learn and innovate. Many reports recommend innovation as a means towards sustainable development. But (Siebenhüner and Arnold, 2007, p.340) *"(…) the literature on environmental and sustainability management for the most part neglects the role of learning and change processes in the implementation of new concepts."* And, as Jiménez-Jiménez and Sanz-Valle suggest (2011, p.408): *"Organizational learning, innovation and performance relate positively to each other. However, research that studies the interrelationships between the three concepts simultaneously is still scarce."* The fact that business innovation for sustainable development, learning, capability and competence building are a little-explored and little-understood area, contributes to the difficulties that our society experiences in responding effectively to the sustainable development challenge. In addition, I want to mention two factors that have attracted my attention in my work as an organizational consultant for businesses in various sectors.

The first factor is the way innovation processes are looked upon and managed. As already argued at the beginning of this chapter, innovation has solved many problems and has generated wealth and advancements in many areas. But these kinds of innovation, focused typically on increasing business results and not on societal and organizational learning and improvement, have also overlooked, excluded or even aggravated social and environmental problems. It may be important to study concrete innovation processes that lead to more sustainable results, and conventional innovation processes, and to research the characteristics of the learning and innovation management methods involved. In that way it may be possible to develop inspiring or exemplary images for the improvement of innovation processes and their management, and for more effective learning for greater sustainable development.

The second factor relates to managerial capabilities and organizational competences for innovation. Innovation processes in and between organizations are executed by people working together. Under the pressure of shareholders and financial markets, focused mainly on short-term results, the attention of management is directed first and foremost at the outcomes of innovation processes, while these outcomes are determined by the quality of cooperation and collective learning in the innovation processes and by the specific capabilities of the involved managers and employees. I therefore think it is important to research which management capabilities and organizational competences contribute to processes of *systematic* learning and innovation that consistently lead to more sustainable results, and how they can be developed. Knowledge in this field would enable the design of management methods and development programs for improved organizational learning and innovation processes.

On the basis of the above, I choose to make systematic innovation processes in business, studied from the perspective of organizational learning, the central theme of this research. In chapter 3, based on literature research, I present the detailed research questions.

1.5 The aim and contribution of the research

The aims of this research are to increase our understanding of learning as part of systematic innovation for sustainable development and business and to develop recommendations for the improvement of (inter-) organizational learning processes.

The research focuses on understanding four specific innovation projects - two focused on economic and two on both economic and environmental issues. It contributes to knowledge and understanding in the following ways: Firstly, the research helps to develop an understanding of the differences in the learning processes and results of the two kinds of projects. Secondly, the applied managerial capabilities and their developmental factors are clarified. Their relation with learning and management satisfaction is analyzed. And thirdly, a conceptual model, theoretical propositions and recommendations for researchers and practitioners are developed.

It is this content and these characteristics of the research that may help policy makers and business management to more effectively build bridges between theories and policies for systematic learning, innovation and sustainable development on the one hand, and the applied methods and work practices on the other. The research follows part of the research agenda we defined earlier (Van Kleef and Roome, 2007a).

I have chosen to research projects in the paper and board producing sector in The Netherlands for the following reasons: First, the sector produces large amounts of materials that are used by probably every person on the planet. Secondly, the sector influences natural environments to a considerable degree through its use of large amounts of energy and natural resources like trees and fresh water, and by applying a wide array of chemicals. Thirdly, paper and board production processes are not very complex and can be easily understood by non-professionals. Fourth, in The Netherlands the sector is regarded as innovative, due to the high pressures of international competition and environmental regulation. Lastly, thanks to an environmental consultancy project for the sector that I participated in, I have some inside knowledge of the sector and its actors, which gave me a higher-than-usual level of access to the companies .

1.6 Outline of the research method. Limits of the research

In chapter 4, I explain the research method in detail. In this section, I sketch only its outlines and the main perspectives that I worked from.

My research method is based on a research philosophy inspired by the work of various scholars. This research should contribute to the development of theoretical insights that are firmly rooted in empirical phenomena that can contribute to the design of measures to improve sustainable business management. Regarding company practice, I have observed the following: that company innovation practices are characterized by diversity on several levels; that (therefore) the results of the research cannot be generalized; that the (professional) cultural orientations of the people involved determine the meanings of words and differences therein; and that innovation processes have the character of social construction processes that involve individual, team and organizational learning.

Using this philosophy and keeping in mind that not much is yet known about learning for innovation and sustainable development, a research method is required that optimizes the relationship of the research with the company practices. I chose to use a deductive approach in combination with an inductive approach in order to integrate the insights derived from literature with the empirical, qualitative data gained from interviews. Thus, my aim was to discover key themes and detailed insights into the dynamics and social experiences of the learning and innovation processes that I researched (Gioia et al., 2012). I used these as a basis for theory development in the field of organizational learning for innovation and sustainable development, and for recommendations to practitioners and researchers.

Furthermore, I made the choice to base the research on case studies. Through interviews with key participants and through the study of documents, I examined four examples of innovation processes in the paper and board producing industry in The Netherlands that differed from each other in a number of ways, focusing on the development histories of the paper industry, the participating companies, and the projects. Interviewing all of the key people involved in the innovation processes, I tried to create multiperspectivistic and developmental pictures of the learning processes and innovation projects. Using semi-structured interviews with open-ended questions, I attempted to reconstruct the dynamics of the learning and innovation processes as seen by the people involved. I then checked these reconstructions, before starting detailed analysis. I analyzed and compared the innovation processes and then formulated conclusions and a theory that may contribute to the design of improved management methods and development programs for organizational learning for innovation and greater sustainable development.

1.7 The structure of the thesis

The structure of this thesis is as follows. In chapter 2, I propose definitions for the main terms that I use. In chapter 3, I explain the background of the research: I present literature research on innovation, sustainable development, (inter-)organizational learning and dynamic capabilities. I present critical observations, literature research on the history and roots of human creative and innovation capabilities, and a research agenda. The chapter ends with three research questions. In chapter 4, I introduce the research philosophy and method, and in chapter 5, I provide a brief overview of the history of the Dutch paper and board industry and clarify the background to its drive to innovate. In chapter 6, I present the four innovation projects that I researched. Then I proceed to the analysis of the data and the construction of Aggregate Aspects in chapter 7. In chapter 8, I perform cross-case analyses, and in chapter 9, I present a synthesis of the research in a conceptual development model of the dynamics of inter-organizational learning for innovation. In chapter 10, conclusions are presented in the form of theoretical propositions and recommendations. I also reflect on the research.

Figure 1.1 presents a graphical overview of the research phases, the different components of the research and the related chapters.

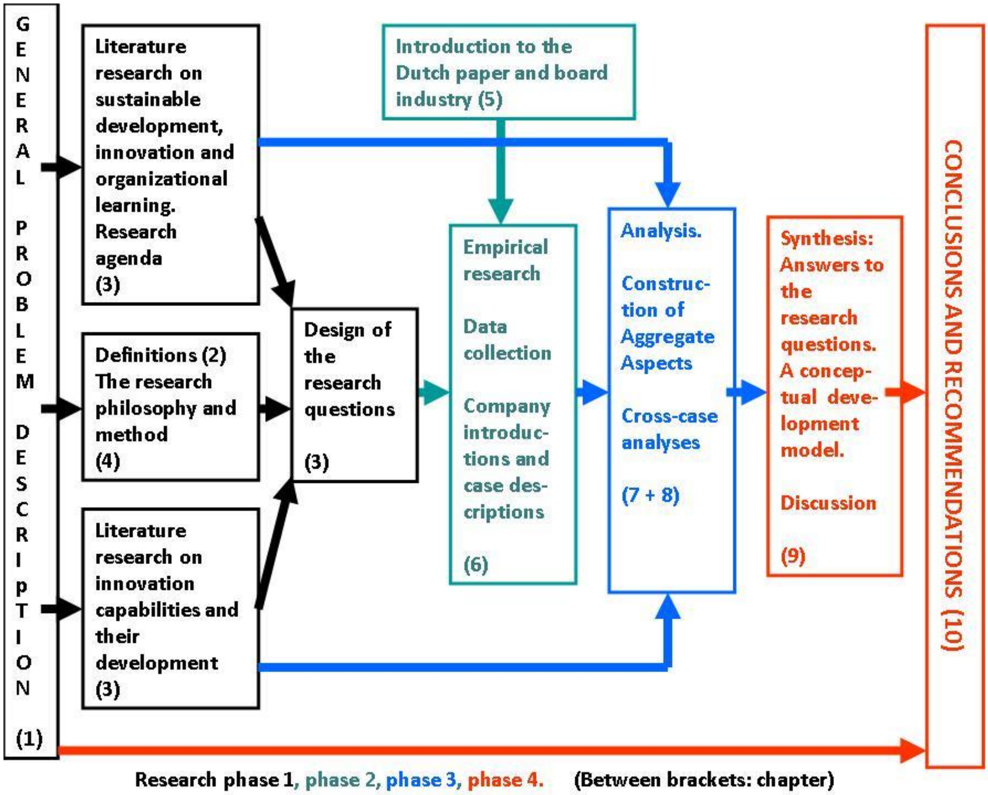

Figure 1.1 Overview of the research

2 Proposed definitions

2.1 Introduction

In chapter 1, I sketched a concise overview of the present state of sustainable development, and I formulated the general problem description that guides this research. I also developed a more specific research focus and presented the aim of this research. In this chapter, I present the definitions that I propose to use for sustainable development, innovation, organizational learning, dynamic capability, competence, project and philosophy. But first, I wish to present my views on definitions in general.

Definitions are always more or less arbitrary, given the seemingly limitless diversity one can find in practice. For a definition to be applicable and practically relevant, it is useful to relate it to empirical situations and their dynamic and changing characters. Therefore, I regard my definitions as temporary constructions that I have chosen for the purposes of this research. I support the perspective of Wittgenstein, who suggests that no definition will ever " (…) *entirely coincide with actual usage, as this usage has no sharp boundary*" (Wittgenstein, 1965, p.19) and that "(…) *the possibility of each individual case discloses something about the essence of the world*" (Wittgenstein, 1922, p.37).

I should also mention that the idea of innovation for sustainable development is relatively new. It is only in the past 25 years that academics and international bodies have linked business innovation processes with sustainable development. This means that the meanings of the terms sustainable development and innovation for sustainable development in company practice are diverse and far from stable, and that other terms are also frequently used, e.g. corporate social responsibility (CSR).

2.2 Sustainable development

In this section, I choose a definition for sustainable development. The first time that sustainable development was defined was at the World Conservation Strategy conference of the IUCN, UNEP and WWF in 1980 (IUCN, 1980). *"This [sustainable development] is a kind of development that provides real improvements in the quality of human life and at the same time conserves the vitality and diversity of the Earth. The goal is development that will be* *sustainable. Today it may seem visionary but it is attainable. To more and more people it also appears our only rational option.”* In 1987 the WCED (Brundtland, 1987, p.43) defined sustainable development thus: *“1. Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It contains within it two key concepts: the concept of 'needs', in particular the essential needs of the world's poor, to which overriding priority should be given; and the idea of limitations imposed by the state of technology and social organization on the environment's ability to meet present and future needs.”* In Van Kleef and Roome (2007a, p.39), following the UNWCED definition, we saw sustainable development as: *“A process of change in which the exploitation of resources, direction of investments, orientation of technological development, and institutional change are made consistent with future as well as present needs”.*

All the definitions mentioned above imply learning on personal, organizational and societal levels. It is important to make that character explicit, in order to specify more clearly the challenge that the ambition of sustainable development raises. Therefore, the definition of sustainable development that I use in this thesis is the following: *Sustainable development consists of processes in which the exploitation of resources, direction of investments, orientation of technological development, and institutional change are made consistent with future as well as present needs.*

2.3 Innovation

In this section I present a short overview of the meaning that the term innovation has in practice and of the theoretical ways in which the term can be understood. Parts of the text are adapted from Van Kleef and Roome (2007b). At the end of this section, I present the proposed definition of innovation.

Innovation as instrumental in professional practices

Innovation is described (Shorter Oxford English Dictionary, third edition) as *“the introduction of a new thing; the alteration of something established”*; as *“a thing newly introduced; a change made in something; a new practice, method etc.; a product newly introduced onto the market”*. It can be understood as “*(…) the successful introduction of something new and useful, for example, introducing new methods, techniques, practices, or new or altered products and services.*” (Dasgupta and Gupta, 2009, p.205). Innovation implies “*(…) the adoption of a new idea or behavior.*” (Jiménez-Jiménez and Sanz-Valle, 2011, p.408). It is “*(…)*

the process of proposing/adopting/developing/implementing a new idea (related to a product/ process/policy/practice/program/behaviour/service) generated internally or taken from outside." (Garcia-Morales et al., 2006, p.22)

In the practices of companies and other organizations, the term innovation is used in relation to a limited number of situations. Innovation is mainly defined as an instrument used to attain the goals of a company or other organization, e.g. cost reduction, improved quality and customer satisfaction, increased market share, or new products and services. It helps companies to deal with the turbulence of the external environment (Jiménez-Jiménez and Sanz-Valle, 2011). Innovation is also employed by governments as an instrument to improve their international competitive position. And in the literature on sustainable development, innovation is seen as an instrument to renew our systems of consumption and production towards more sustainable development. In order to be viable, eventually the outcomes of innovation processes must have economic significance (Edquist, 1997). Innovation is not necessarily related to problem solving (Nooteboom, 2000a), but usually related to improving competitiveness and economic success, and often pushed by technology. On a more abstract level, I view the instrument of innovation as studied from three main perspectives: as the outcome of a process, as a process that consists of sub-processes, and as a management issue.

Innovation as the outcome of a development process

The literature distinguishes different types of innovation, defined in terms of the outcomes of the innovation processes. I name the following (for examples see Dasgupta and Gupta, 2009; Nadler and Tushman, 1999; Hammer, 2004; Jiménez-Jiménez and Sanz-Valle, 2011).

- Incremental innovations: referring to small, stepwise changes that can be termed innovative
- Radical innovations: meaning innovations that change the roots of products or services, and generate new lines of development and business
- Technological innovations: focusing on new technological aspects
- Process innovations: referring to the renewal of business processes
- Product innovations: focusing on innovations in products or their characteristics
- Organizational innovations: meaning innovations in the organizational structure and work methods
- Administrative innovations: referring to new procedures, policies and organizational forms

- Operational innovations: referring to innovations in operational day-to-day procedures
- Managerial innovations: meaning innovations in management style or methods
- Methodical innovations: focusing on innovations in research, development and work methods
- Social innovations: referring to innovations in the character or quality of the relationships between actors in an organization or society
- Institutional innovations: meaning innovations in institutional arrangements in a society that constitute the basis of political, economic or cultural life.

Incremental innovations are close to existing practices, and may therefore be realized more easily than radical innovations, which require the adaptation of systems of production and consumption or the development of new technologies (Nooteboom, 2000a) and therefore meet resistance from inside, as well as outside, the organization (Chakravorti, 2004). Radical innovations are occasionally needed in order to renew the core business and to deal with discontinuities caused by pressures from outside the industry or by technological change (Utterback, 1996).

Innovative organizations often generate radical product and process innovations that challenge dominant designs. As is illustrated by the positive correlation between the production of R&D-intensive goods and high productivity (growth) (Tushman and Nadler, 1996), product and technological innovations can increase efficiency more than process innovations can.

Organizational and social innovations can also promote growth in productivity and competitiveness, as they can improve the application of new technology (Lundvall, 1990; Edquist, 1997). Research indicates that significant economic impacts can only be created through a combination of technological, product, process, organizational and managerial innovations (Freeman et al., 1990), because customers, employees, firms, products and production processes operate in highly interdependent, dynamic systems (Utterback, 1996). As a consequence, radical innovations invariably require change or concerted effort by a range of loosely connected actors (adapted from Van Kleef and Roome, 2007b).

Innovation as a learning process consisting of sub-processes

Innovation may also be understood as a learning process of professionals and organizations in which several sub-processes can be distinguished. *"Innovation is* *a learning process in which valuable ideas are transformed into new forms of added value for the organization and its stakeholders. The innovation spiral comprises of individual and social learning at the work place, knowledge creation, and innovation."* (Dasgupta and Gupta, 2009, p.206). For example, the process of innovation can be described as the processes of inventing, further developing and applying a new idea (Galbraith, 1996); as a process in which an idea is developed and, after that, adopted in practice by other parties; as individual and collective learning processes *"(…) through which workers (…) actively remake their occupational practices."* (Høyrup, 2012, p.16) or *"(…) to find new ways of solving problems."* (Alegre and Chiva, 2008, p.315). Or, from the Schumpeterian view, innovation can be described as a process of creative destruction in which radical innovations, put into production and brought onto the market by new companies, destroy existing companies. Innovation processes can also be distinguished in explorative and exploitative processes, focused on incremental and on radical changes respectively (Noteboom, 2000a and 2006).

Through the sub-process 'inventing a new idea', innovation is linked with creativity. One definition of creativity is the following, according to Margaret A. Boden (2004, p.1): "*Creativity is the ability to come up with ideas or artefacts that are new, surprising and valuable*." Boden distinguishes three forms of creativity (2004, p.3-6) that may lead to surprising and new ideas or artefacts. The first arises when familiar ideas are combined into new configurations – what Boden calls combinatory creativity. The second form is termed explorative creativity. And the third stems from the processes of reframing established mental models of the world – so that what was previously viewed as impossible to conceive becomes possible. Boden (2004) describes combinatory creativity as follows: "(…) *making unfamiliar combinations of familiar ideas. (…) These new combinations can be generated either deliberately or, often, unconsciously.* (…) *making — and also appreciating — the novel combination requires a rich store of knowledge in the person's mind, and many different ways of moving around within it.*" (p.3). Explorative creativity, on the other hand, is described as follows: "(…) *someone who comes up with a new idea within that thinking style is being creative in the second, exploratory, sense.* (…) *it can enable someone to see possibilities they hadn't glimpsed before*" (p.4). And creativity through transformation arises in the following way: "*A given style of thinking, no less than a road system, can render certain thoughts impossible — which is to say, unthinkable. (…) thinking styles can be changed* (…) *so that thoughts are now possible which previously (within the untransformed space) were literally inconceivable*" (p.6) (Adapted from Van Kleef and Roome, 2007b)

I propose that some form of creativity is a prerequisite for the innovation sub-processes that are called further development and application (Galbraith, 1996). I do not, however, adopt an evolutionary perspective on innovation, as too many fundamental differences between biological evolution and economic development have been identified (Nooteboom, 2000a, 2009).

Innovation studied from the perspective of management

Whether it is seen as the outcome of a process or as a process that consists of sub-processes, the fact that innovation in practice is predominantly seen as an instrument to reach specific goals raises the question of how to manage innovation processes. This leads us to the third perspective: that of innovation as a management issue.

I view the innovation management question in terms of the scale of the practical situation in which innovation plays a role (the functioning of a team, an organization, a product chain, a company sector, a province, a country or a geographic region) and the involvement of different actors and their (professional, national, regional, ...) cultures. For example, with regard to the scale of business and product sectors, the processes of development and application can be viewed as a combination of exploration processes (in which existing products and processes are adapted incrementally or radically through the search for and application of new assets) and exploitation processes (in which the variety of products and processes decreases while their efficiency increases). The exploitation element of the process may lead to stable product/market combinations as the basis for a next phase of innovation (Nooteboom, 2000a and 2000b; Galbraith, 1996). The following questions are then relevant: Which stakeholders can be identified? Which role do they play? And which interests and cultures do they represent? How can they be brought into communication and cooperation with each other? How can their collective learning be stimulated and managed? The answers to these questions imply the involvement of organizational and management structures, the application of management philosophies and methods, and, most likely, the need for different management capabilities.

"Increasingly, it has been recognized that firms need outside relationships for innovation, in the development of new products, production processes, markets, or forms of organization, and for learning, in the development of new competencies" (Nooteboom, 2006). Together with the requirement that innovations as outcomes have economic value, this implies that in innovation processes, from idea to application, culturally different actors (e.g. customers, suppliers, producers, regulators, researchers) work together in processes of

exploration, consultation, negotiation, design and development. Innovation processes can therefore be seen as social constructionist processes (Pinch and Bijker, 1989) that involve learning and that need suitable structures of communication, cooperation and management in order to be effective. Issues of creativity, learning and innovation are therefore related to the field of management and organization philosophy and method.

The proposed definition of innovation

I propose to describe the innovation process as follows, integrating the perspectives of innovation as an outcome, as a process that consists of sub-processes, and as a management issue: *Innovation is a process of social construction among different actors, not necessarily from one organization, with the aim to generate new value for the involved actors. An innovation process introduces new policies, management methods, work methods, technologies, products, services, production processes, and institutional, organizational, cooperative or systemic arrangements*. *Innovation makes use of structures for management, deliberation, negotiation and cooperation, and can be differentiated into sub-processes that mutually influence each other (e.g. explorative and exploitative, or diverging and converging processes).* As a process of social construction, innovation is based on the processes of social interaction and recombination that are part of organizational learning.

2.4 Organizational learning

In the literature, organizational learning is viewed from many different perspectives, because "*(…) there is no consensus around what organizational learning is or how to best facilitate it*" (Barker Scott, 2011, p.2). Dasgupta and Gupta offer an overview of perspectives (Dasgupta and Gupta 2009, p.207 and based on Gieskes et al., 2004):

– The information processing perspective: that characterizes learning as *"Increasing and improving knowledge through processing information"*. Phases that are recognized are acquisition, distribution, interpretation and storing of information and knowledge (Sanz Valle, 2011, p.998)
– The contingency perspective: in which learning is "*Adapting to changes in the environment*"
– The psychology perspective: from which learning is seen as "*Continuous and concerted sharing of assumptions in the context of collective action*"

- The systems-dynamics perspective: learning is "*Developing understanding of the complex causalities of social reality*"
- The strategic perspective: that says learning is "*Building unique competencies for competitive advantage*"
- The production-management perspective: that sees learning as "*Improving efficiency through experience*".

In general, organizational learning is defined from a functionalist perspective as the process by which organizations develop changes in their models to maintain or improve their performance or competitiveness in an environment that is changing continuously (Alegre, 2008). Organizational learning is seen as an antecedent of understanding company environments, innovation and competitive advantage (Sanz-Valle et al., 2011; Barker Scott, 2011, p.1; Yeung, referred to in Dasgupta and Gupta, 2009, p.207).

Organizational learning is regarded as a development process, e.g. as "*(…) the process by which knowledge about action outcome relationships between the organization and the environment is developed*" (Dixon, 1992), or "*(…) as a constant process that extends across time, allowing new abilities and knowledge to be developed(…), increasing an organization's capability to carry out actions and improving organizational performance"* (Garcia-Morales et al., 2006, p.22). *"In general, it is considered as the process of developing new knowledge and insights derived from common experiences of people within the organization (…)"* (Sanz-Valle et al, 2001, p.998). Siebenhüner and Arnold (2007, p.341) present a similar process-oriented definition, but one in which *"(…) the concept of sustainability served as a fundamental framework."*

Others focus on specific qualities of learning processes and define organizational learning from the paradigm from which they view organizations (Karatas-Özkan and Murphy, 2010). Those who operate from a social constructionist paradigm see organizational learning as taking place within communities of practice and consisting of building intersubjective new meanings, understandings, knowledge or worldviews through dialogue and discursive participation. Learning cannot be separated from doing and social interaction, *"(…) from cognitive insight and behavioural application"*, or from "*(…) place or space, the players, and their histories"* (Barker Scott, 2011, p.6). Those who operate from a post-modernist or critical theorist paradigm see organizational learning as the expression of different views and opinions, and as the development of new meanings, related to injustices, inequalities and the dynamics of power, social structures and tensions between privileged or marginalized groups. In the social constructionist, post-modernist and critical theorist paradigms more narrative ways of developing understanding can be discerned so as to gain a deeper insight into the learning experiences of people in organizations (Karatas-Özkan and Murphy, 2010; Barker Scott, 2011).

On the basis of a literature review, Sambrook presents a framework that studies different phases or activities within a process of organizational learning from the perspective of group or team learning. She bases the framework on Crossan et al (1999) and Crossan and Bedrow (2003). Sambrook (2005, p.148-150) distinguishes an individual level of organizational learning with intuiting processes (defined as *"the preconscious recognition of the pattern and or possibilities inherent in a personal stream of experience"*) and interpreting processes (defined as *"the explaining of an insight or idea to one's self and to others"*). Secondly, she discerns learning on a group level, connecting interpreting and integrating processes (of which the latter is defined as *"the process of developing shared understanding amongst individuals and the taking of coordinated action through mutual adjustment. Dialogue and joint action are crucial to the development of shared understanding (…)"*). And there is an organizational level of learning connecting the integrating with the institutionalizing processes (of which the latter is defined as *"the process of ensuring that routine actions occur. Tasks are defined, actions specified and organizational mechanisms put in place to ensure that certain actions occur"*). In her framework, Sambrook shows how intuiting processes eventually may result in institutionalizing processes, and how institutionalizing processes in their turn may stimulate the processes of integrating, interpreting and intuiting.

Also, other scholars believe that *"Organizational learning refers to learning at the system rather than individual level"* (Dixon, 1992). It is defined as the learning of individuals and organizations, that consists of processes by which knowledge, capabilities and behavior are systematically changed, informed by experience (Høyrup, 2012; Jiménez-Jiménez and Sanz-Valle, 2011). In a similar way, Brenda Barker Scott defines organizational learning as *"(…) a multilevel process (…)"* in which "*(…) individual knowledge is shared, combined, expanded, tested, and applied amongst individuals to become group or community knowledge*" that "*(…) in turn, influences what and how groups, communities, and individuals learn*" (Barker Scott, 2011, p.1).

On the basis of her literature review, Barker Scott (p.13) describes organizational learning as a cognitive and a behavioral process whereby new insights lead to new behaviors and/or new behaviors lead to new insights; that is an active, social and dynamic process facilitated through people reflecting together and acting together and that is related to knowledge, which has a dynamic character; that is exploited and can be further developed; and that occurs through individuals, amongst groups and communities, in routines, norms and other organizational features.

Barker Scott (2011) suggests that the exchange and combination of ideas, insights and knowledge is facilitated through “(…) *processes, forums, networks, partnerships or communities that enable the requisite social interaction (exchange, synthesis, co-creation) amongst colleagues”* (p.17) and that complement the organization’s learning intent, knowledge strategy, interpretive schedules and learning style (p.19). Following a similar line of thinking, Jiménez-Jiménez and Sanz-Valle (2011, p.416) suggest that “*(…) firms should promote the acquisition of new knowledge, for example by making employees attend fairs and exhibitions regularly (…)*” and that “*(…) they should enhance the knowledge distribution and interpretation within the firm, for example by using formal mechanisms to guarantee the sharing of best practice among different employees and departments, making employees talk to each other, using teamwork, (…)*”. Sanz-Valle et al., 2011, p.1007) find that *“(…) two types of organizational culture (adhocracy and hierarchy) have an indirect effect on technical innovation and that OL mediates the relationships between the former two variables.”*

On the basis of this mapping exercise, taking into account the multi-sided nature of learning in and by organizations, I propose to define organizational learning as *the processes of social interaction in which intuitions, ideas, understandings, meanings, information or knowledge are shared and recombined in individuals, groups, teams and the organization.* As processes of social interaction and recombination, organizational learning processes form an indispensable basis for innovation processes. And they are enabled by the business processes and policies that are part of the dynamic capability of an organization.

2.5 Competence

The Shorter Oxford English dictionary (fifth edition) describes competence as *“Power, ability, capacity, (to do, for a task, etc*.).” Consequently, I interpret the meaning of organizational competence as: The power, ability or capacity of an organization for a certain task. Prahalad and Hamel (1990), however, focus on learning processes. Their definition of competence is *“(…) the collective learning in the organization, especially how to coordinate diverse production skills and integrate multiple streams of technologies”.*

The capabilities of employees, combined with each other in teams and connected through organizational structures, policies, methods and routines, are the building blocks of organizational competence. Organizational competence includes the organization of work, the involvement of employees, the commitment to working and communicating across boundaries within the organization, and the delivery of value to customers and other stakeholders. Organizational competence is seen as the basis of competitiveness. It is a specialized form of organizational learning that enables a company to offer products and services of value to customers and to innovate to generate new products and services, while at the same time adapting to changing circumstances faster than competitors. As I am interested in understanding the learning processes that contribute to greater sustainable development, the definition of Prahalad and Hamel (1990) is the one that I use in this research. (Adapted from Van Kleef and Roome, 2007a)

2.6 Dynamic capability

The concept of dynamic capability is a relatively young research domain and it is not yet well defined. It stems from the resource-based view (RBV) on companies, and in general it says that unique resources alone cannot explain competitive advantages in dynamic markets. Organizations need some kind of 'dynamic capabilities' to adapt to changing, dynamic environments in order to remain competitive (Eisenhardt and Martin, 2000; Wang and Ahmed, 2007; Di Stefano and Peteraf, 2010; Harris, Kaefer and Salchenberger, 2013). Not pretending that this is complete, however, below I mention a few of the most important aspects of dynamic capabilities, as described in recent literature. The concept may be interesting with regard to the challenge to innovate and contribute to sustainable development, because of its focus on how to deal with changing environments.

According to the research of Eisenhardt and Martin (2000), the concept of dynamic capabilities includes empirically known organizational and strategic processes (routines) that enable companies to reconfigure their resources to create value and match or create market change. These processes have the character of best practices that may be common to more companies, and therefore the competitive advantage does not lie in the dynamic capabilities but in the specific resource configurations that are the result of learning and adaptation. These configurations cannot remain unique in the long term, and the strategic imperative for competitive advantage, according to Eisenhardt and Martin (2000), is change.

However, Wang and Ahmed (2007) propose that dynamic capabilities consist of firm-specific adaptive, absorptive and innovative capabilities that are not processes. They say the essence of dynamic capabilities is *"(…) a firms behavioural orientation in the adaptation, renewal, reconfiguration and recreation of resources, capabilities and core capabilities responding to external changes*" (p.43) to deliver superior value to customers. Following the same line of thinking, the research of Easterby-Smith et al. (2009) concludes that dynamic capabilities can be characterized as "*(…) higher level capabilities which provide opportunities for knowledge gathering and sharing, continual updating of the operational processes, interaction with the environment, and decision making evaluations*" (p.S7).

In his review (Barreto, 2010) Barreto defines a firm's dynamic capability as a multi-dimensional construct, as "(…) *the firm's potential to systematically solve problems, formed by its propensity to sense opportunities and threats, to make timely and market-oriented decisions, and to change its resource base*" (p.271). He sees a dynamic capability as "(…) *something structured and persistent*" that, as a potential, is "(…) *not synonymous with success*" (p.273). Harris et al (2013) refer to the framework defined by Teece and see dynamic capabilities as consisting of capabilities for '*(…) sensing opportunities and threats, seizing the opportunities and managing the threats, and the reconfiguration of resources*" (Harris et al., 2013, p.400). In relation to corporate social responsibility, Ramachandran (2011, p.289) suggests that dynamic capability consists of a sense-and-respond capability (associated with processes of knowledge generation, social issue identification, solution development, and impact assessment) and execution capability (associated with processes of detailing, and production and delivery infrastructure building). Wu et al (2012) state that firms need scanning, identification and reconfiguration capabilities to effect competitive advantage and a strategic change toward sustainability.

Nooteboom (2009, p.204-205) distinguishes dynamic capabilities on the level of individuals ("*(…) to adopt knowledge from others, (…) and to help them to absorb your knowledge, (…), and governance capabilities (…)*"), and on the level of organizations ("*(…) the intellectual and behavioural ability to collaborate with other organizations, at optimal cognitive distance, with governance capabilities to deal with relational risks of dependence and spillover*"), and "*(…) the ability to employ a heuristic of invention for developing exploitation into exploration (…). This requires great governance capabilities to deal with internal variety and integrate it into a new organizational focus*."

The review by Di Stefano and Peteraf (2010) shows that so far the concept of dynamic capabilities in the literature is predominantly linked with internal matters, organizational routines and the individual cognition and skills of managers. For example, Harris et al (2013), supported by case studies, propose that dynamic capabilities are supported both by managerial and organizational processes. And the case studies by Narayanan et al (2009) show that the cognitive orientations of managers play a major role in the development of dynamic capabilities.

Theory built by Ednilson de Oliveira Cabral (2010) links adaptive, absorptive and innovative dynamic capabilities to different types of innovations and to higher or lower levels of sustainability. The same logic is followed by Castiaux (2012), who links different types of dynamic capabilities (sensing, seizing and transforming) to different levels of change (incremental, renewing and regenerative) and different levels of sustainable innovation (responsible green, efficient green and differentiated green).

To sum up, the views of scholars on the relationship between the concepts of dynamic capabilities, innovation and competitiveness have been developed in two different ways. One path emphasizes the concrete managerial, governance, communicative or organizational business processes and routines in which dynamic capabilities are said to reside and that may contain commonalities across firms. However, in general this elaboration is not done in a manner that is empirically supported or understood very well. A second development path focuses on the higher level and supposedly firm-specific behavioral orientation that is expressed in the more abstract adaptive, absorptive and transformative, or sensing, seizing and reconfiguring actions of companies. The relationship with sustainable development has been described by only a few scholars, though not yet in a way that might support managers in practical efforts to innovate for sustainable development.

On the basis of this survey, I opted for the following definition: *Dynamic capability consists of the policies and business processes on the level of individuals, groups and the organization that enable a company to interact with its environment, to share information, to develop new and common meanings, and to develop and reconfigure capabilities and resources.* Dynamic capability contains more than just organizational learning alone. It also contains policies. Through policies and business processes it supports organizational learning processes that, in their turn, enable innovation processes.

2.7 Project

As this research focuses on the analysis of innovation processes in four innovation projects, I will explain here the definition of project that I propose. I follow the Oxford Dictionary which describes 'project' as *"An individual or collaborative enterprise undertaken usually for industrial or scientific research, or having a social purpose*" (Shorter Oxford English Dictionary, 2002). It is *"(…) carefully planned to achieve a particular aim (…)*" (Oxford dictionaries Online, 2013). This definition fits innovation processes undertaken as a result of economic issues and those undertaken as a result of both economic and environmental issues.

2.8 Philosophy

In this research, I frequently use the term 'philosophy'. As this word can be understood in many different ways, I wish to clarify here the meaning I have attributed to it in the context of the research.

I follow the Shorter Oxford English Dictionary (2002). The term 'philosophy' originally stems from Greek, meaning "*love, study or pursuit of wisdom, truth or knowledge"*. However, down through the ages, the word has also come to mean *"The branch of knowledge that deals with the principles of a particular field or subject"*, e.g. natural philosophy or moral philosophy. And it may also mean *"A set or system of ideas, opinions, beliefs, or principles of behaviour based on an overall understanding of existence and the universe; a philosophical system or theory; a view, an outlook".*

In this research, I use the word 'philosophy' in combination with the terms research, management, innovation, development, sustainable development, teamwork, communication, learning, and improvement. It is then used to indicate: *The systems of ideas, opinions, beliefs; the principles of behavior; or the views and outlooks that actors in the innovation projects make use of, consciously or unconsciously, in relation to the specified subjects*.

2.9 Concluding remarks

The main aim of my research is to increase our understanding of learning and innovation for sustainable development and business, and our understanding of the applied managerial capabilities and their developmental factors; and also to develop theoretical propositions and recommendations for researchers and practitioners. In this chapter, I proposed the definitions I will use for sustainable development, innovation, organizational learning, competence, project, dynamic capabilities and philosophy.

Sustainable development *consists of processes of inter-organizational and societal learning in which the exploitation of resources, direction of investments, orientation of technological development, and institutional change are made consistent with future as well as present needs.*

Innovation *is a process of social construction among different actors, not necessarily from one organization, with the aim to generate new value for the involved actors. An innovation process introduces new policies, management methods, work methods, technologies, products, services, production processes, and institutional, organizational, cooperative or systemic arrangements. Innovation makes use of structures for management, deliberation, negotiation and cooperation, and can be differentiated into sub-processes that mutually influence each other (e.g. explorative and exploitative, or diverging and converging processes).* As a process of social construction, innovation is based on the processes of social interaction and recombination that are part of organizational learning.

Organizational learning *is the processes of social interaction in which intuitions, ideas, understandings, meanings, information or knowledge are shared and recombined in individuals, groups, teams and the organization.* As processes of social interaction and recombination, organizational learning processes are supported by the business processes and policies that are part of the dynamic capability of an organization. The definition of competence that I use is *the collective learning in the organization, especially how to coordinate diverse production skills and integrate multiple streams of technologies.* An organizational competence is a specialized form of organizational learning.

Dynamic capability *consists of the policies and business processes on the level of individuals, groups and the organization that enable a company to interact with its environment, to share information, to develop new and common meanings, and to develop and reconfigure capabilities and resources.* Dynamic capability entails more than just organizational learning alone. It also entails policies. Through policies and business processes it supports organizational learning processes.

A project is defined as *an individual or collaborative enterprise undertaken usually for industrial or scientific research, or having a social purpose. It is carefully planned to achieve a particular aim*.

The term philosophy *indicates the systems of ideas, opinions, beliefs; the principles of behavior; or the views and outlooks that actors in the innovation projects make use of, consciously or unconsciously, in relation to e.g. the subjects research, management, innovation, development, sustainable development, teamwork, communication, learning, or improvement.*

In the next chapter, I present literature research on the capabilities to innovate, on organizational learning in relation to innovation and sustainable development, and on capability development for innovation. Four critical observations are made, and a research agenda and three main research questions are set out.

In chapter 4, the research method and philosophy are explained, and chapter 5 presents the history of the Dutch paper and board producing industry. In chapters 6, 7 and 8, the data from the projects that I researched are presented and analyzed. Chapters 9 and 10 round off the research with answers to the research questions, conclusions and recommendations.

3 Literature research, critical observations and research questions

3.1 Introduction

In chapter 1, the aims of this research were outlined: To increase our understanding of learning and innovation for sustainable development and business, and our understanding of the applied managerial capabilities and their developmental factors; and to develop theoretical propositions and recommendations for researchers and practitioners.

In order to specify research questions that enable data collection that suits these foci, in this chapter I introduce literature research on managerial capabilities for innovation and sustainable development, on organizational learning in relation to innovation and sustainable development, and on capability development for innovation. In section 3.2, I explain the research methodology and heuristics that I applied in the literature research. In section 3.3, I study literature from the field of innovation in order to create an overview of the capabilities that are suggested with regard to innovating as an organization for competitive reasons. Two critical observations are presented.

In section 3.4, I present literature from the field of organizational learning related to innovation and sustainable development, and again two critical observations are presented. In 3.5, I research what the literature has to say 1) about capabilities to discover unknown options and to collaborate under diversity, and 2) about factors that determine the history and roots of human creative and innovation capabilities. I present literature from cognitive science, geosciences, anthropology, psychology, sociology, education and philosophy. Integrating their findings helps me to define five groups of factors that are influential in the history and roots of human creative and innovation capabilities. In section 3.6, a research agenda is presented, and in 3.7 the research questions.

Sections 3.2, 3.3, 3.5.1 and 3.6 are taken from Van Kleef and Roome (2007a). The original text has been redistributed over chapter 3. It has been adapted on minor points to facilitate integration into this thesis.

3.2 Literature research heuristics

In 2004, I used a relatively simple heuristic to identify research papers with a focus on capabilities for innovation. Dutch library databases were searched using a keyword search. The search was directed at literature on innovation for competitiveness and then at literature on innovation for sustainable development. In the case of the subject of innovation for competitiveness, the search was focused using the keywords ‘innovation’, ‘business’, ‘organization’, ‘strategy’, ‘technology’, ‘competence’, ‘learning’, and ‘network’. In the case of innovation for sustainable development, the search was focused using the keywords ‘innovation’, ‘environment’, ‘sustainable’, ‘sustainable development’, ‘strategy’, ‘technology’, ‘learning’, and ‘network’. The books and articles that were identified through this search were then studied with two objectives in mind: to identify other relevant literature, and to establish the capabilities and competences for innovation described in the material. In addition, a search was also conducted for relevant articles in two journals: Business Strategy and the Environment and the Harvard Business Review.

The source material available on capability development for innovation for sustainable development was generally to be found in more specialized journals and books than was the case for the material on capability development for innovation for competitiveness. From the reviewed body of literature six core categories of capabilities as well as the sub-categories were identified (see the tables II.1 and II.2 in Appendix II). The findings are presented in section 3.3.

In the last months of 2012 and the beginning of 2013, I executed three additional searches for relevant and more recent literature with the same methodical heuristic, in order to update and extend the literature research and to focus the research questions. These searches were limited to literature that was published in 2006 or later. In this literature research, I focused on identifying the main recommendations for further research. The critical observations were mirrored to the policy documents of four international organizations to verify their validity. The findings of these three additional searches are presented in section 3.4 and in tables II.3 – II.6 in Appendix II.

One keyword search was executed to identify recommendations for research in the fields of sustainable development and innovation. The applied strings of keywords were ‘literature review AND sustainable development or sustainability’ and ‘literature review AND innovation AND skill, capability, competence, sustainable, or learning’. After making the selection, this search provided me with six literature reviews, three in each field.

The second keyword search was used to identify recommendations for research reported in research papers with a focus on organizational learning, and on organizational learning in relation to sustainable development, CSR, innovation, capability or competence. I searched Dutch library databases and Google Scholar using the following strings of keywords: ‘literature review AND organizational learning’, ‘organizational learning AND sustainable development or CSR', and 'organizational learning AND ability, capability, skill or competence'. I gave preference to literature reviews, as they provide an overview of the main issues to be researched in the field. After a first superficial screening on the relevance of the titles, this search provided 43 titles. After a second screening, based on the abstracts, 20 titles remained to be studied. 11 of the titles were literature reviews.

The third keyword search was executed in March and April 2013 after the results of the other searches had become clear. This search enabled me to more exactly determine the details of recommendations for research in the fields of inter-organizational learning and dynamic capabilities, in order to further focus the research questions. One search used the following strings of keywords: 'inter-organizational AND sustainable, sustainability, learning or literature review'. The other search focused on 'dynamic capabilities AND sustainable, corporate social responsibility, learning, development or review'. The results of both searches gave me 37 titles, of which 19 remained after a detailed screening of the abstracts.

3.3 Literature research on the capabilities to innovate. Critical observations

This chapter first draws on the established literature on innovation to identify the demands placed on actors in systems of production and consumption when they contribute to innovation. I look at the managerial capabilities that enable innovation within networks of actors and how they might be developed. I also study the differences between the capabilities that firms need to innovate for competitive reasons alone as opposed to innovation focused on sustainable development.

The capabilities to innovate for competitiveness

Managerial capabilities and organization structures may not support the strong competence needed to deal innovatively with discontinuous change when it arises (Utterback, 1996). Two approaches have been put forward to support the need for continuous innovation arising out of constant competitive pressures and the need to combine different types of innovation.

First, if a company has to change rapidly, strategic variety and experimentation are more suitable to creating competitive advantages than optimization (Hamel and Valikangas, 2003). An effective combination of competencies for optimization and innovation may be found through the development of an 'ambidextrous' integrated organization with competencies, cultures and capabilities for efficiency, consistency and reliability on the one hand, and for experimentation, improvisation and entrepreneurial abilities on the other (Tushman and O'Reilly, 1997; O'Reilly and Tushman, 2004; Volberda and Van den Bosch, 2004).

Secondly, understanding innovation processes makes it necessary to take into account all the important factors that influence innovations. Together these factors form 'systems of innovation' (Edquist, 1997; Lundvall, 1992; Foray, 1997). In these systems, different types of actors experience different learning processes (Edquist, 1997) and therefore have different perspectives on problems and opportunities. Moreover, the innovative capabilities of a company may be enlarged through co-production of knowledge with partners at all levels in the organization. It has been suggested that this can be achieved through domestic and international inter-firm collaboration (Cooke and Wills, 1999), and technology alliances that help a company to develop new competencies faster than through internal development (Doz et al., 1997). However, others have advocated the active involvement of actors from various company networks (like final users, workers, suppliers, research and training institutions, competitors, distributors, consultants, and NGOs) in the innovation process (Brown, 1997; Prahalad, 1997; Lundvall, 1990 and 1992; Ritter and Gemunden, 2003a; Edquist, 1997; Nooteboom, 2000a).

Companies strengthen their competence to innovate by developing the capabilities of employees within the organization (Hargadon and Sutton, 2000). With the exception of Tushman and Nadler (1996), most authors on innovation have not written explicitly about the capabilities that contribute to the competence to innovate for purely competitive reasons. However, the capabilities that are embedded in the work of leading authors in the field of innovation are related to systems thinking, learning, combining and integrating, thinking inventively, networking and coalition building.

A key issue is how these capabilities compare with those identified by authors who focus on the competence to innovate and contribute to sustainable development. Below, I therefore consider what the literature has to say about innovation for sustainable development and the capabilities that support that form of innovation.

The capabilities to innovate for sustainable development

A variety of approaches to the realization of sustainable development are proposed in the literature. Sustainable development is often seen to require the adoption of an integrated view of innovation that brings together economic, environmental and social concerns as a basis for system changes (European Commission, 2001). There is widespread consensus that radical innovations are needed to decrease the environmental and social impacts of our systems of production and consumption and to deal effectively with the challenges of sustainable development (VROM-council, 2002). These innovations are primarily meant to integrate environmental and social interests with economic interests, and to bring about change that goes beyond the singular criteria of competitiveness and economic success (Roome, 2001c). For example, sustainable business takes into account the interests of future generations, biodiversity, animal protection, human rights, life cycle impacts, and principles like equity, accountability, transparency, openness, education and learning, and local action and scale (Welford, 1996). Authors have suggested that sustainable development requires that the concept of 'efficiency' (the economic value added in relation to the aggregated resource use) be extended to include 'eco-efficiency' and 'socio-efficiency' (the economic value added in relation to the aggregated ecological and social impact, respectively). Moreover, concepts such as 'eco-effectiveness' and 'socio-effectiveness' have been suggested as ways to deal with absolute thresholds in social and ecological sustainable development (Dyllick et al., 2002). Others have suggested that efficiency might be complemented or replaced by the notion of sufficiency (European Commission, 2001). Deciding the size and character of social and environmental thresholds and determining sufficiency criteria is seen to require input from actors outside of firms as units of production (Roome and Œstland, 1998). The case for collaboration of different actors in innovation for sustainable development is therefore argued on four main grounds – it is more problem-oriented, involves deeper learning and more joint action, and builds more knowledge of context-dependency.

In the case of problem orientation, the diversity of actors is important in helping to identify and specify the issues that need to be addressed by innovation. It is proposed that progress toward sustainable actions involves collective problem finding, developing future visions of systems that are more sustainable, and identifying the technological and other innovations needed to achieve those visions (European Commission, 2001). These steps can be taken in open processes of innovation using input from a broad range of actors, including customers, suppliers, NGOs, and other stakeholders (Roome, 2001c; Foster et al., 2000; Winter and Steger, 1998). Networks of actors can be brought together in platforms for referencing and exchanging ideas and information. These platforms can be designed as opportunities to create settings that are currently not available for discussing sustainable development issues (Roome, 2001c). A strategy that leads a company to guide or participate in these platforms and networks is consistent with the creation of competitive advantages such as lower costs, the preemption of competitors and a favorable future market position, and can help the company acquire increased legitimacy through transparency and collaboration with external stakeholders (Hart, 1995). The problems identified provide a central focus for innovation, rather than following the technology-push model in which technological innovations search for applications.

In the case of learning, diversity in networks provides greater potential for learning and is important in bringing forward potential solutions that are able to resolve complex problems (Boons and Berends, 2001). It has been suggested that companies and non-profit organizations may collaborate, for example, in marketing affiliations, certification schemes, company support for environmental projects, alliances to promote environmental awareness and education, and environmental management alliances (Rondinelli and London, 2001) as well as in new product development and innovation (European Commission, 2001). Indeed, actors from inside and outside the company who do not share cultures, interests and perspectives and who are not familiar with one another can provide the required creative tension and ensure environmental and social inputs that enable the development of knowledge and the formation of new innovation networks (Clarke and Roome, 1995).

It is argued that joint action toward sustainable development should also be organized by and with the consent or participation of many different stakeholders, especially people who are locally involved, through inclusive networks spanning organizational levels (UNWCED, 1987; Shilling and Osha, 2003; European Commission, 2001; Clarke and Roome, 1995). The call for collaborative action acknowledges the fact that more radical changes require the consent and participation of many suppliers of products and services and the users of existing and future products in change.

Finally, socio-economic policies are increasingly seen to involve initiatives that are locally and regionally specific if structural solutions are to be achieved (Martens, Rotmans and De Groot, 2003). Moreover, it is argued that what is sustainable is often determined by local circumstances and conditions (UNWCED, 1987; Roome, 2001c) and this specificity requires input towards innovation from locally knowledgeable actors so that innovations can be adapted to context.

Innovation as problem finding, learning and action for sustainable development involves networks of actors with very different perspectives, interests, and cultures spanning different levels and contexts. Examples of the challenge and complexity of these multi-actor innovation processes are found in the literature.

One approach to actor input is referred to as strategic bridging. This provides an instrument for interaction between firms and external stakeholders, but it is vulnerable to efforts by participants to control the organization, to internal or financial problems, and to participants leaving the organization (Garcia et al., 2003; Westley and Vredenburg, 1991).

The inclusiveness of the concept of sustainable development and the consequent diversity in the networks that work toward sustainable development may lead to a lack of clarity of purpose, to an unmanageable agenda, to communication dominated by ideology, to relatively slower progress than might be imagined with business-driven technological innovation, and to poor selection of key actors. The network should be able to demonstrate the value added in concrete ways if it is to survive (Selman and Wragg, 1999). For example, the vision and strategy generated using input from many different stakeholders might be more difficult to develop or accomplish without the involvement of those actors (Roome, 2001c).

There may be tension between the participation of diverse actors and the openness of the process on the one hand, and the interest of firms to appropriate knowledge for commercial ends on the other. For coalition building, the ability to build trust and agree on basic values should be present (Roome, 2001c; Roome, 2001a; Partidario and Vergragt, 2002). Research (Scott, 1998) has also shown that the effectiveness of forums may be hampered by the restrictions of finances, legitimacy and infrastructure, by competition between groups and individuals, and manipulation of the agenda. Other difficulties that have to be overcome (European Commission, 2001) include: differences in management styles and culture, weak collaboration between the private and NGO sectors, the absence of initiatives that bring together partners across sectors and interests, risk aversion in forging new collaborations around innovations, a shortage of capital in systemic thinking and systems integration, scarcity of facilitation skills, and skills to facilitate multi-party learning processes.

These challenges suggest that innovation for sustainable development is a specific and complex organizational competence that is different to the competence of innovation for mainly competitive reasons. The capabilities highlighted in the work of various authors who support the competence to contribute to sustainable development are to be found in the fields of systemic thinking, learning, integrating, developing alternative models and methods, networking, and building coalitions that span diverse groups. Below, I compare the capabilities to innovate for competitiveness and for sustainable development, and I look in more detail at the nature of the main differences.

Critical observations

Above, I reviewed the literature in order to identify the capabilities required to innovate for competitive purposes and those required for sustainable development. Six comparable categories were found in which the capabilities for innovation for competitiveness and innovation for sustainable development overlap (see tables II.1 and II.2). Although this overlap may suggest, contrary to what I found above, that the capabilities needed for the two kinds of innovation are similar, it does not take into account the possible different characteristics of these capabilities when they are applied. For example, networking and social capabilities may be implemented in very different forms (qualities) in different situations. Their specific form decides whether they support innovation and contribute to sustainable development or not.

Comparing the sub-categories in tables II.1 and II.2 leads to two critical observations:

1. *The discovery of unknown options*

   The capability to discover new or unknown options is rarely mentioned in the reviewed literature. In the case of innovation for competitive reasons, six out of fourteen authors briefly mention this capability (Nooteboom, 2000a; Tushman and Nadler, 1996; Brown, 1997; Volberda and Van den Bosch, 2004; Hamel and Valikangas, 2003; Hargadon and Sutton, 2000), without any references to methodical approaches to their development. In the case of innovation for sustainable development, only 4 out of 18 authors (Roome, 1998a, 2001c and 2001a; Partidario and Vergragt, 2002; VROM-raad, 2002; Hawk, 1995) mention this capability. Moreover, as sustainable development is seen to require radical innovation, this capability becomes even more critical. *Lack of attention to the development of methods and capabilities for discovering unknown options is seen as a serious omission in both bodies of research, especially given the importance of inventiveness in the development of sustainable options.*

2. *Accommodating diverse perspectives*

   The literature on innovation for sustainable development often refers to networks of actors that are larger and more diverse than those in the literature on innovation for reasons of competitiveness. For example, these networks involve interests that represent environmental and social concerns, and the network specifically includes actors with local knowledge. Comparison of the six categories of capabilities shows that the focus in innovation for sustainable development is on communicating and collaborating with very diverse and culturally unfamiliar (and/or local) networks of actors, on integrating their diverse perspectives, criteria, and information processing and decision styles; these concerns are not found in the literature on innovation for purely competitive reasons. These qualitative differences in network membership demonstrate the differences in the type, scale and character of the issues in the two kinds of innovation processes.

Capabilities have to be able to accommodate these very diverse perspectives while operating within a multi-organizational system that is sensitive to locality.

I studied policy documents from the European Union, the United Nations, the World Bank and the World Business Council for Sustainable Development to verify whether these findings correspond with their priorities and goals or not.

With regard to critical observation 1, the discovery of unknown options, the European Environmental Agency acknowledges the need for different kinds of innovations: *"The challenge is to find out how we can redesign our economic models such that we can generate growth and improve the quality of life across the world without damaging the environment, while also protecting the interests of future generations. (…) Clearly, it will require technological innovation. But it requires lots of other changes, too — to the way we organize businesses; the way that we design cities; the way we move people and goods around; the way we live, essentially."* (EEA, 2012, p.7). The World Business Council on Sustainable Development, the World Bank and the United Nations note that the complexity of issues demands ingenuity, innovation and collaboration: *"Global issues such as climate change, water stress or waste management are highly complex; (…) The most effective solutions involve collaboration among businesses, nongovernmental organizations, policy makers and other stakeholders"* (World Business Council on Sustainable Development, 2011, p.8). *"Coping with climate change will require all the innovation and ingenuity that the human race is capable of (…) And ingenuity is the only possible answer to a problem that is politically and scientifically complex — the quality that could enable us to act differently than we have in the past"* (World Bank, 2009). "*There is therefore an urgent need to find new development pathways that encourage creativity and innovation in the pursuit of inclusive, equitable and sustainable growth and* *development. Such an effort must be matched by reshaping the global partnership for development to support implementation and to ensure effective accountability mechanisms at all levels*" (United Nations System Task Team on the post-2015 UN development agenda, 2012, p.19). And: *"As there are no blueprints for the most effective "enablers", ample space would need to be ensured for experimentation and adaptation to local settings"* (United Nations System Task Team on the post-2015 UN development agenda, 2012, p.22).

Verification of critical observation 2 shows that the international organizations are well aware of the need to accommodate diverse perspectives and to collaborate with local actors. *"The complexity of our global decision making structures mirrors the complexity we find in the environment. It is difficult to strike the right balance between legislation, private sector initiatives and consumer choices. It is equally difficult to find the 'right level' to target — ranging from local to global"* (EEA, 2012, p.15). The United Nations Conference on Sustainable Development (2012) also refers extensively to the subject: *"76. We recognize that effective governance at the local, subnational, national, regional and global levels representing the voices and interests of all is critical for advancing sustainable development. (…) We therefore resolve to strengthen the institutional framework for sustainable development, which will, inter alia: (…)*
(c) Underscore the importance of interlinkages among key issues and challenges and the need for a systematic approach to them at all relevant levels;(…)
(h) Enhance the participation and effective engagement of civil society and other relevant stakeholders in the relevant international forums and in this regard promote transparency and broad public participation and partnerships to implement sustainable development;"
"101. We underline the need for more coherent and integrated planning and decision making at the national, subnational and local levels as appropriate and, to this end, we call on countries to strengthen national, subnational and/or local institutions or relevant multi-stakeholder bodies and processes, (…)"

The European Commission (2011) stresses the need for dialogue: *"Policy makers, at EU, Member State and regional level, need to engage in active discussion with business and civil society about the policy conditions necessary to overcome the barriers to resource efficiency"* (p.20).

The World Business Council on Sustainable Development (2011) warns that: *"Different organizations also have different organizational cultures. (…) it is essential to carefully consider cultural and geographic differences, and accommodate these as part of your project plan"* (p.9).

And the United Nations System Task Team on the post-2015 UN development agenda (2012) emphasizes the participation of local actors: *"75.*

Promoting environmental sustainability, including sustainable, integrated natural resource management, with the full participation of local organizations, can build resilience at all levels of society and realize multiple benefits" (p.27-28)
"92. Implementation of a post-2015 development agenda will depend, critically, on effective governance capacities at national, local and municipal levels, including political commitment and leadership; and on the legal and economic empowerment of people, especially those most excluded, and of their civil society organizations, to participate effectively in national and local decision-making" (p.32)
"Partnerships to implement a post-2015 UN development agenda should reflect the full range of actors that have the potential to support sustainable development (governments, civil society, the private sector and foundations)" (p.36).

On the basis of this verification, I conclude that critical observations 1 and 2 are valid departure points for the design of the research.

3.4 Literature research on organizational learning in relation to innovation and sustainable development. Critical observations

There is a growing body of literature that links organizational learning to issues of performance, sustainable development and diverse forms of innovation (e.g. Alegre and Chiva, 2008; Høyrup, 2012; Jimâenez-Jimâenez, 2011; Sanz-Valle et al., 2011; Siebenhühner et al., 2007; Preuss, 2010; Schiederig et al., 2012).

As already stated in chapter 2, I discerned different approaches to the subject in the literature. I proposed to view organizational learning as *the processes of social interaction in which intuitions, ideas, understandings, meanings, information or knowledge are shared and recombined in individuals, groups, teams and the organization.* As processes of social interaction and recombination, organizational learning processes form an indispensable basis for innovation processes.

In the literature that I studied, it was suggested that organizational culture and different kinds of capabilities are related to organizational learning. This view is supported by our findings on the capabilities for innovation and sustainable development. In both bodies of reviewed literature, there is a recognition of the need for managerial capabilities for learning and developing in cooperation with other actors. The other categories of capabilities that were found (i.e. for systemic thinking; for integrating business, environmental and social problems, perspectives and information; to develop alternative business models, methods and trajectories; to find new options; networking and social capabilities; coalition and collaboration building capabilities) can be seen as capabilities that are part of the organizational culture, that contribute to learning capabilities, and that support organizational learning processes. Because of the linkages between organizational learning processes and issues of sustainable development and innovation on the one hand, and managerial capabilities and organizational competences on the other, it is justifiable to study innovation processes from the perspective of organizational learning processes and capability and competence development.

Studying and grouping recommendations for further research mentioned in recent literature reviews in the fields of innovation, sustainable development and organizational learning, and in nine other recent articles on organizational learning, I found several categories of recommendations for research. These recommendations may be considered as representative for their fields, as they have been derived from studies that cover numerous articles and research projects (see tables II.3 and II.4 for the studied literature).

Four out of the six literature reviews recommend that more empirical research be done in order to test conceptual frameworks or to validate models that have inductively been developed from literature. In the field of innovation management, I found recommendations in two of the three innovation literature reviews (Smith, Busi, Ball and Van der Meer, 2008; Schiederig, Tietze and Herstatt, 2012) to research in a deeper manner the management of innovation processes, i.e. the dynamic capabilities that help to transform process innovation and the management of innovation processes at micro-level. In one review (Frishammar, Kurkkio, Abrahamsson and Lichtenthaler, 2012) it is recommended that we deepen our understanding of the work processes in process innovation projects, and their dynamics of predevelopment, creativity, learning and transformation in time. The authors also recommend research of the system aspects of innovation, specifically with regard to the integration of process and product innovation, because they are often both needed.

In the field of sustainable development, recommendations for further research focus on the systems perspective (Klewitz and Hansen, 2011; Van Huijstee, Francken and Leroy, 2007; Crutzen and Herzig (2012). Two out of the three literature reviews recommend that more research be done on the contributions and effectiveness of partnerships in sustainable development and on sustainable development-oriented innovation projects in order to better understand the accompanying (inter-)organizational learning processes, networking and collaboration. It is also recommended in two of the reviews that multidisciplinary research be carried out, in addition to research that combines different perspectives on innovation (actor – institutional), different aspects of innovation projects (ecological – economic – social) and different kinds of innovation projects. One literature review (Klewitz and Hansen, 2011) finds that more research is needed to find out which unique characteristics of SMEs support sustainable development-oriented innovation.

Also, the need for more empirical research is identified (in half of the articles) to gain more insight into complex and dynamic relationships, to validate organizational learning approaches, and to study the relations between organizational learning and sustainable development, innovation and performance. In the majority of the articles (Sambrook and Roberts, 2005; Karatas-Özkan and Murphy, 2010; Barker Scott, 2011; Nooteboom, 2006; Yu, 2011; Alegre and Chiva, 2008; Siebenhuhner and Arnold, 2007; Müller and Siebenhüner, 2007) more research is recommended on understanding and managing group or team learning and (inter-) organizational (sustainable development-oriented) learning processes.

Other subjects that a minority of the authors recommend for further research are the complexity of organizational learning processes, the development of a systems perspective in organizational learning, the need to work with concrete practical business problems, a more effective sharing of knowledge in organizations, the possible role of public policy in initiating sustainable development-oriented organizational learning processes, and the conditions that promote the transformation of experience into knowledge.

Studying the findings from literature research in innovation, sustainable development and organizational learning, I conclude that, next to the broadly recognized need for more empirical research, the main subjects that have been recommended for further research are within the fields of systems perspective and systems management, namely

- Networking, collaboration and (inter)organizational, group or team learning processes
- The integration of ecological, economic and social aspects and product and process innovation processes
- The capabilities to manage innovation processes at micro-level and to transform process innovation.

On the basis of these findings, I executed additional literature research focused on inter-organizational learning and dynamic capabilities and that followed the heuristic that I described above (see tables II.5 and II.6 for the studied literature).

The recommendations for research identified in literature on inter-organizational learning are the following. More than half of the articles (Siebenhüner and Heinrichs, 2010; Smith, 2012; Lampela, 2009; Rondeaux et al., 2009) recommend more research on the explanatory contextual, processual, managerial and social factors of inter-organizational learning in order to develop relevant dynamic models and to be able to facilitate effective management practices. Two of the articles recommend research on competence development in relation to inter-organizational learning and open innovation (Banyan, 2010; Du Chatenier, 2009).

In my literature research on dynamic capabilities, I studied twelve recent articles, of which half recommend research in order to better understand the development of dynamic capabilities in relation to business processes (Wang and Ahmed, 2007; Easterby-Smith, Lyles and Peteraf, 2009; Di Stefano, Peteraf and Verona, 2010; Barreto, 2010; Harris, Kaeferand and Salchenberger, 2013; Narayanan and Douglas, 2009). Five articles recommend further research on the development of dynamic capabilities in relation to the role and contributions of managers (Ramachandran, 2011; Easterby-Smith, Lyles and Peteraf, 2009; Di Stefano, Peteraf and Verona, 2010; Narayanan and Douglas, 2009; Swift and Hwang, 2008). In addition to these subjects, four of the articles also recommend more empirical research. Other recommendations for research focus on the relationships between dynamic capabilities and change and transformation, performance, the external environment and conceptual issues.

Critical observations

Comparison of the recommendations in more recent literature on innovation, sustainable development, (inter-)organizational learning and dynamic capabilities leads to two additional observations.

3. *Empirical research, and understanding dynamic development processes*

   Høyrup and Wu et al suggest that: "*The learning perspective seems to offer a promising basis for knowledge production in the field of innovation*" (Høyrup, 2012, p.6) and "*How firms develop and apply dynamic capabilities to address the distinctive challenges involved in corporate change toward sustainability is yet to be fully explored*" (Wu et al. 2012, 233). However, this literature research has revealed that many studies have been based on literature research alone or on theoretical concepts that were not built on empirical data. The presented models are mainly of an abstract, generalist nature, mostly presenting ideal situations and not concrete empirical examples or practical advice on the application in firms of the concepts and frameworks (Sambrook and Roberts, 2005; Dasgupta and Gupta, 2009; Jiménez-Jiménez and Sanz-Valle, 2010; Sanz-Valle et al., 2001; Nooteboom, 2006; Schiederig et al., 2012; Frishammar et al., 2012; Smith et al., 2008; Van Huijstee et al., 2007; Klewitz and Hansen, 2001; Crutzen and Herzig, 2012; Haamann and Basten, 2012). Models are also often of a linear, simplifying nature that picture cause-effect relations and fail to take into account feedback loops and mutual influences between factors in complex, dynamic system situations in firms (García-Morales et al., 2006; Siebenhüner and Arnold, 2007). To facilitate the understanding and systems thinking that the challenge of sustainable development demands, and to become able to bridge the gaps that apparently exist between theory and practice, science should help to model the complexity, interrelationships, dynamics and development that underlie empirical situations. The literature research indicates that, through their nature, most present theories and models on inter-organizational learning insufficiently support companies in dealing with the complexities and dynamics of multi-sided issues and multi-actor situations in projects related to innovation and sustainable development. One suggestion is that "(…) *we have to move from abstract modes of communicating knowledge to more narrative ways of conveying insight and understanding* (…)" (Karatas-Özkan and Murphy, 2010).

The lack of empirically grounded models that take into account the dynamics and systemic complexities of inter-organizational learning processes for sustainable development does not help policy makers and managers to picture, understand and systematically facilitate these processes in practice and realize consistent progress towards sustainable development.

4. *Inter-organizational learning and dynamic capabilities*

Within the domains of innovation, sustainable development and organizational learning, the literature points towards a lack of insight into the fields of networking, collaboration and (inter-)organizational or group or team learning processes (Klewitz and Hansen, 2011; Van Huijstee, Francken and Leroy, 2007). Also, a lack of knowledge is identified on the integration of ecological, economic and social aspects and of product and process innovation processes (Van Huijstee, Francken and Leroy, 2007; Crutzen and Herzig, 2012). In order to be able to develop a more dynamic picture of concrete learning processes with multiple actors and issues, literature indicates that a deeper understanding is needed of the explanatory contextual, processual, managerial and social factors of inter-organizational learning (Siebenhüner and Heinrichs, 2010; Smith, 2012; Lampela, 2009; Rondeaux et al., 2009). Recommendations for managers may be developed by researching the relation of the development of dynamic capabilities with business processes and with the role and contributions of managers at micro-level (Wang and Ahmed, 2007; Easterby-Smith, Lyles and Peteraf, 2009; Di Stefano, Peteraf and Verona, 2010; Barreto, 2010; Harris, Kaefer and Salchenberger, 2013; Narayanan and Douglas, 2009; Ramachandran, 2011; Swift and Hwang, 2008).

Research that provides deeper insight into the factors that have a critical influence on the quality of empirical inter-organizational learning processes and of the development of dynamic capabilities, contributes to the design of more dynamic models for systematic learning for innovation and sustainable development.

The United Nations System Task Team on the post-2015 UN development agenda (2012), the European Commission (2011) and the World Bank (2009) all acknowledge the need for more empirical research and for understanding dynamic development processes (critical observation 3). *"Founded on core values, transformative change will be fuelled by policy innovation and experimentation, as well as mutual and participatory learning"* (The United Nations, 2012, p.22). *"87. Science and technology, and information derived from their application, will be a major source of innovation for development"* (The United Nations, 2012, p.30). *"The transition to a green and low-carbon economy will require significant innovation, from small incremental changes to major technological breakthroughs. (…) Basic and applied research should identify challenges and guide actions, including social sciences research to develop our understanding of behavior"* (European Commission, 2011, p.8-9). "*Effective, affordable backstop mitigation technologies for transforming energy systems will not be available in the future without active research and demonstration initiatives that move potential technologies along the cost and learning curves. To that end, developed countries need to provide leadership in developing and bringing new technologies to market and in sharing knowledge from their experiences of deployment*" (World Bank, 2009).

Critical observation 4 covers the theme of inter-organizational learning and dynamic capabilities. The United Nations Conference on Sustainable Development (2012) finds this subject very important. "*64. We acknowledge that involvement of all stakeholders and their partnerships, networking and experience-sharing at all levels could help countries to learn from one another in identifying appropriate sustainable development policies, including green economy policies. We (…) welcome the voluntary exchange of experiences as well as capacity-building in the different areas of sustainable development."(…)*
"272. We recognize the importance of strengthened national, scientific and technological capacities for sustainable development. (…) To this end, we support building science and technology capacity, with both women and men as contributors and beneficiaries, including through collaboration among research institutions, universities, the private sector, governments, non-governmental organizations and scientists."

The European Commission suggests that *"Exchanging information on routes to resource efficiency between partners in value chains and across sectors, including SMEs, can prevent waste, boost innovation and create new markets"* (European Commission, 2011, p.6).

Also, the United Nations System Task Team on the post-2015 UN development agenda (2012) sees knowledge exchange under the condition of diversity as a basis for sustainable development. "*78. In all these areas, technology transfer, capacity-building and international cooperation will be critical for sustainable progress, especially for developing countries. Building "knowledge societies", more sustainable lifestyles, access to quality life-long education, freedom of expression and cultural and linguistic diversity will be essential for transformative development based on the principles of human rights, equality and sustainability"* (p.28).

Evaluating the findings above, I conclude that the two critical observations identified from the literature research fit the policies, methods and goals that are recommended by recognized international organizations.

3.5 Capability development for innovation

As a follow-up to the critical observations above and to prepare for data collection and analysis, in this section I study the specific capabilities to discover unknown options and to collaborate under diversity, plus the factors that according to scholars from different fields (cognitive science, geosciences, anthropology, psychology, sociology, education and philosophy) form the roots of human creative and innovation capabilities. It is not my intention to discover specific characteristics of capabilities for sustainable development, but rather to map existing insights about innovation capabilities in general.

3.5.1 Capabilities to discover unknown options and to collaborate under diversity. Organizational arrangements.

Below, I examine what the literature says about the capabilities to build the organizational competences to discover new [unknown] options and to collaborate in highly diverse teams that might span organizational interests while including local actors. I then present an overview of the formal and informal organizational arrangements that facilitate the development of capabilities for collaborative innovation for sustainable development. This is done using the architecture that Tushman and Nadler (1996) suggest and that clarifies the organizational requirements for innovation, namely the capabilities of individuals, organization arrangements, and the informal organization.

<u>Capabilities to discover unknown options</u>

The capability to think independently
The invention of new products, processes, skills, or indeed business models, requires that employees learn to think for themselves (Schuck, 1996). Individual specialization is the basis for developing diverse skills and the capacity to innovate (Tushman and Nadler, 1996). And, team members who have developed their own specific capabilities may complement each other and increase the possibility of bringing forward combined ideas to solve complex problems (Levine, 2002). Independent thinking generates diversity, with the potential to contribute to organizational learning and deal with complexity (Boons and Berends, 2001).

The capability to think inventively
The ability of individuals to think inventively is crucial for innovation directed at finding new solutions to problems. Leonardo da Vinci is regarded as a master of radical invention. The heuristic method he employed is demonstrated in his notebooks (Richter, 1970a) and says something about the process of innovation as invention. A rigorous methodical process involving observation (specifically of nature), reflection, imagining, and reproducing, so that vision was turned into practice through design, was characteristic of his scientific and technical discoveries. He sought not to repeat what had been done by others, but rather invented his own vision, making many studies, sharpening his capabilities in

observation, combining ideas across different scientific fields, and imagining various solutions to a problem. He was mainly concerned with the *conception* of his inventions, and only after thorough understanding of his subject did he go from theory to practice. His method of innovative thinking gave rise to many inventions that were not actually realized until centuries later, for example, the concept of the bicycle and that of systematic automation in industrial processes (Bramly, 1994; Richter, 1970a).

Beyond these elements of method, John Seely Brown (1997) attributes importance to the ability to use intuition in the process of research and innovation. While Levine (2002) similarly identifies the importance of intuition, he also recognizes a set of 'higher learning' abilities. These include critical thinking to assess the validity and quality of ideas, people and things, and problem-solving abilities to preview outcomes, assess feasibilities, mobilize resources, think logically, consider and select strategies, undertake self-monitoring and seek to deal with impasses. Creative thinking embraces behaviors and characteristics that promote originality. For example through the ability to be controversial, deviate from accepted norms, suspend self-evaluation, combine technical skills in original ways, develop a unique personal style, freely associate idea and avoid making assumptions.

The capabilities that form the basis for invention in a systematic process of innovation include observing empirical reality in its details, reflecting critically and intuitively on that reality, imagining possibilities and confronting these images with reality. This leads to the development of a creatively constructed new vision in relation to a well-founded understanding of reality. Companies should seek to organize for these capabilities in collaborative innovation teams. In the informal organization, those with a strongly developed capability to think innovatively take on the role of 'idea generators' supported by 'champions' or 'internal entrepreneurs' who propose and gain support for innovative ideas from those with resources in organizations (Tushman and Nadler, 1996; Roome, 2001c).

Capabilities to collaborate in highly diverse teams, including local actors

Four kinds of capabilities can be distinguished in regard to innovation carried out in highly diverse networks, platforms or teams.

Capabilities to create and maintain trust

The capability to build interpersonal trust is essential if people with diverse interests and perspectives are to commit to a common cause that involves the exchange and development of information and knowledge across teams or networks. Roome (2001c) argues that "*Developing trust is a fundamental concern when new combinations of actors have to deal with paradox, examining their own and collective mental models. Working together with other, new communities of practice, operating in new settings for learning and exploring possibilities for profound change….*' (p.30-31). The way trust is built is unique in each organization. It includes: the capacity to act with discretion, consistency between words and deeds, frequent and rich communication, fair and transparent decisions, establishment of shared visions and language and the recognition of the contribution of different professional 'languages'. Indeed, Roome (2001c) suggests that trust '*is informed by the perception of outcomes*'. This in turn is supported by people assuming accountability for trust, their personal connections, the contribution of things of value, and the disclosure of expertise and limitations (Abrams et al., 2003).

Building trust in teams involving highly diverse stakeholders is problematic because of opposed interests and points of view. There is greater potential for disputes and power struggles, and for unmanageable agendas dominated by clashing ideologies (Selman and Wragg, 1999). There is often tension between the pragmatic difficulties in building trust on which successful collaboration is based and the need to collaborate when trust is lacking. Successful trust management requires the ability to deal with collaborations in which trust is initially lacking and to build trust where this is possible. It demands continuous attention to the trust that exists, as well as to the risks that stem from a lack of trust, and that time be taken for trust building (Vangen and Huxham, 2003). Levine (2002) identifies the need for 'social thinking abilities' as a means to resolve conflicts without resorting to aggression and to monitor own interaction: abilities for self marketing and image development, collaboration, and for reading and acting on social information.

It has also been suggested that innovative teams need the trust of those with the power in organizations (organizational gatekeepers) that can support innovations with resources and other organizational assets. This implies a '*cascade of trust*' (Roome, 2001c) that runs through organizations and the networks that link the members of innovative teams to those with the organizational power to provide resources or broker new partnerships and strategic collaborations to enable ideas to be translated into new technologies, products, services, routines or relationships.

Capabilities to solve problems collectively in diverse teams

It only becomes possible to confront accepted ways of doing things when individual and tacit knowledge are expressed to others as explicit knowledge

(Tushman and Nadler, 1996). This confrontation is a basis for innovation and makes innovation a social process involving communication across professional boundaries and the barriers those boundaries create. It requires great care, attentiveness and patience (Cooke and Wills, 1999). Similarly, in order to enable an organization to learn as a group, individual expertise must be combined with skills in collective problem solving, communication, conflict resolution and team building (Tushman and Nadler, 1996). People must be willing to address their blind spots, to learn new skills and to test the assumptions and attitudes that underlie their routine behavior (Argyris, 1996). Team learning improves when teams are designed explicitly for learning, when their challenge is framed as an organizational one, and when learning in action is supported by an atmosphere of psychological safety (Edmondson et al., 2001).

Conflicts about ideas can be consciously created in a team and used as a way to stimulate creativity (Sutton, 2001). Conflict can arise over alternative courses of action, interpretations and perspectives. Conflict can contribute to increases in the innovative performance of teams when it is well managed. This usually occurs when discussion is thorough and creative, and when premature closure of a subject is avoided. This leads to better and deeper understanding, more complex perspectives, better information and the enhancement of implementation (Eisenhardt et al., 1998). The ability to create and manage conflict is an essential capability in effective team functioning.

Research by Sweet, Roome and Sweet (2003) demonstrates the influence of personal information processing and decision styles on the functioning and outcomes of teamwork. Personal information processing and decision styles are related to the degree of development of attention controls for the intake of information and their output. The former controls the focus, the depth and the span of attention, the activity of the mind, and the level of satisfaction that occurs when information is taken in. The latter, attention output controls, relate to the previewing of results, considering options, the rate at which activities are conducted, the quality of output, and learning from the past (Levine, 2002). In solving complex problems, such as those associated with systemic sustainable development issues and with their economic, social and environmental aspects, guidance by a manager who is skilled in systemic thinking or integrating different aspects of a situation, and who can support collaborative action in the team, is important to effective team work. This guidance requires a reflexive capacity on the part of the team facilitator and team members on how different styles of information processing and decision affect their work and the work of the team (Sweet, Roome and Sweet, 2003).

Networking capabilities

It has been suggested that the quality of interaction between people is one of the most critical success factors in organizational change programs, and that this quality depends on the openness of management directing the programs (Kleiner and Roth, 1997). An open and responsive managerial attitude to different perspectives generates more new knowledge for sustainable development than do closed attitudes. To achieve openness, managers must be willing to loosen control, to find a balance between managing and being managed, and to pro-actively anticipate change, as well as observing and reacting (Ritter and Gemunden, 2003b).

Individuals who support networks by linking different communities of practice containing different knowledge sets arising inside and outside a company need to be equipped with communication and spanning skills that provide the basis for commitment building, learning and creativity. This involves an ability to communicate across the specialized language created by different bodies of knowledge (Roome, 2001c) and to co-ordinate (Nooteboom, 2000a). A company striving to innovate for sustainable development needs managers with highly developed networks and networking skills, and with capabilities to facilitate change at all levels, both inside and outside the company (Clarke and Roome, 1999). This is matched by strong teamwork capabilities and capabilities to communicate with customers and people outside a company on various organizational levels (Brown, 1997). Managers also need the willingness and ability to follow up in their own organization on recommended changes. They need to be able to deal with the stress of compromising with stakeholders over values or processes, while at the same time trying to win support in their home organizations for the outcomes of negotiations (Westley and Vredenburg, 1991).

Individuals with these networking capabilities act as ‘boundary spanners’ providing their colleagues with external information (Tushman and Nadler, 1996) or information across otherwise separate communities of practice (Roome, 2001c). Managers linking a company to a network should represent a cross-section of the operational and administrative units in the company (Rondinelli and London, 2001) in what Clarke and Roome (1999) had earlier described as a ‘porous company’. Adequate networking capabilities show up in timely, honest and complete communication and information, and an empathy and equity of treatment (Strong, Ringer and Taylor, 2001).

Capabilities to form and maintain strong relationships

Strong relationships, often referred to as social capital, increase productivity, creativity, the speed of learning and innovation. They contribute to making a company work effectively (Prusak and Cohen, 2001; Rondinelli and London, 2001). However, the skill to form and maintain relations is often not formally recognized and/or rewarded (Fletcher, 1999). It also appears to demand the capacity to stimulate action-learning networks (Clarke and Roome, 1999) that are backed by formal organizational sponsorship or resources as part of the cascade of trust previously identified (Roome, 2001c). Research also suggests that "*relational aspects tend to dominate factors causing coalition failure*" (Gössling, Jansen and Oerlemans, 2005).

Enabling factors

I now turn my attention to the enabling or facilitating systems and structures through which informal and formal organizational arrangements support the development of capabilities for collaborative innovation. I consider informal and formal arrangements in turn. Research of Janowicz-Panjaitan and Noorderhaven (2008) indicates that both formal and informal learning behaviors stimulate learning outcomes in alliances and that they are complementary and mutually reinforcing, but also that the positive effect of formal, orchestrated actions weakens at higher levels, and that they can even hinder informal actions.

Informal organizational arrangements

Organizational learning for innovation can be developed and routinized because it is determined or constrained to a large degree by the organizational design, attitude, strategic management, leadership, and culture of a company (Hargadon and Sutton, 2000; Nooteboom, 2000a; Prahalad, 1997; Johnson and Sohi, 2003). Company culture promotes innovation when it supports attention to the unpredictable as well as the routine, when it encourages risk-taking, and the development of nonstandard solutions that cannot be managed by formal control systems. Strong cultural norms can promote creative processes as well as their implementation (Tushman and O'Reilly, 1997; Tushman and Nadler, 1996; Schuck, 1996; Johnson and Sohi, 2003; Ritter and Gemunden, 2003a). These include the norms found in the vision, values and purpose of the company and its innovation processes. These provide focus and a common objective, and enable improvement of the company's learning activities (Vaill, 1996; Nonaka, 1996; Peters and Waterman, 1996; Nooteboom, 2000a; Tushman and Nadler, 1996). Alignment of the values, strategic process and management attitude can encourage openness to ideas and diverse perspectives, and commitment to learning (Clarke and Roome, 1999; Roome, 2001b). A long-term vision, one which incorporates collaborative activity, contributes to the success of partnerships between a company and other organizations, whether they be non-profit organizations (Rondinelli and London, 2001) or others (Clarke and Roome, 1999; Leufkens and Noorderhaven, 2011). An organizational culture that is characterized by an innovative orientation, stability and trustworthiness is positively linked with strong alliance capabilities and relationship performance (Koen, Beugelsdijk and Noorderhaven, 2005). Informal communication networks also enable the fast exchange of information and effective problem solving (Tushman and Nadler, 1996). Institutions, especially the rules of informal institutions, and proximity in networks influence the degree of trust and embeddedness, and the quality of the collaborative behavior of an actor (Gössling, 2004, 2007).

Formal organizational arrangements

In addition to the informal arrangements within organizations, innovation is also fostered by formal arrangements. The "*self-definition of these organizations' identities and* [strategic - HvK] *roles*" (Leufkens and Noorderhaven, 2011, p.440) may support or hinder collaboration in multi-organizational projects. Formal teams, committees, meetings and project managers can bring diverse functions into contact with each other and promote collaboration and the exchange of information and ideas. The way that meetings are convened and structured influences the extent of innovation (Roome and Bergin, 2000). Formal venture organizations may support the development of innovations very dissimilar to the existing organization and its culture (Tushman and Nadler, 1996). It is suggested that organizational attention to the information processing and decision styles of managers who work in innovating teams or collaborations has an influence on the outcomes of team success (Sweet, Roome and Sweet, 2003). Moreover, guidance and support are needed to help team members to develop personal and interpersonal skills of creativity and strategy development, and to foster healthy team processes (Tushman and O'Reilly, 1997). Companies can use formal training, performance measurement systems and management processes to organize for strategic variety and experimentation (Hamel and Valikangas, 2003). Senior teams that are diverse in terms of functional backgrounds, competencies and ages can be used to manage change processes (Tushman and O'Reilly, 1997). Joint evaluation, staffing and appraisal contribute to shared ownership of problems and the acceptance of innovations. The design of incentives, jobs, job rotation, careers and education programs can be adapted to stimulate creativity and the exchange of information and experience (Tushman and Nadler, 1996).

A company's environmental program can contribute to participative learning if continuity in the program is assured and employee participation is given priority (Vickers, 2000). To enable forums to function, a professional approach is needed that ensures recognition of the forum, sufficient funding and qualified staff (Scott, 1998). Developing networking capabilities needs the support of sufficient resources, a network orientation toward human resources management, and the availability of important information (Ritter and Gemunden, 2003a).

3.5.2 Understanding capability development: The history and roots of human creative and innovation capabilities

Introduction

In order to effectively design and analyze empirical research aimed at answering the critical observations, it is useful to gain a deeper understanding of the historical development of creative and innovation capabilities in humans and the factors that have influenced this development. Therefore, in this section I present papers from the fields of cognitive science, geosciences, anthropology, psychology, sociology, education and philosophy, which when combined can give us an overview of the history and roots of human creative and innovation capabilities. The aim of this section is to develop categories or sensitizing concepts that help me to analyze and understand the findings from the cases.

The nature of human creativity

As stated above in 2.3.3, Boden (2004, p.1) defines creativity as follows: "*Creativity is the ability to come up with ideas or artefacts that are new, surprising and valuable*. (…) *It's not a special 'faculty' but an aspect of human intelligence in general: in other words, it's grounded in everyday abilities such as conceptual thinking, perception, memory; and reflective self-criticism. So it isn't confined to a tiny elite: every one of us is creative, to a degree.*"

A number of authors have pointed out that human creativity is a fundamental and natural driver that needs to be given room for expression if humans are to have a fulfilling and satisfying existence (Fromm, 1990; Dewey, 1997a; Boden, 2004). Levine (2002, p.209) writes: "*Every child has within him a creative voice crying out for discovery*." (...) "*Creative opportunities liberate a child's mind to cross into personal zones of higher thinking. In being creative, kids unshackle their minds and discover novel possibilities for self-expression and mental free play.*" Dewey points out that creativity is a natural capacity of individuals. He views creativity from the viewpoint of human-development, suggesting that the drive to explore and find solutions for problems has its starting point at the beginning of our lives. "(…) *the native and unspoiled attitude of childhood, marked by ardent curiosity, fertile imagination, and love of experimental inquiry, is near, very near to the attitude of the scientific mind*" (1997a, p.vii). In her analysis of creativity, Boden (2004) also demonstrates that very young children possess the skills to easily change the routines and concepts by which they explore and produce images, ideas and answers to the questions they pose themselves or are posed by others. (Adapted from Van Kleef and Roome, 2007b)

Biological roots of human innovation capabilities

The geosciences tell us how life on earth, ever since its origin three-and-a-half billion years ago, has tried to cope with and influence changing circumstances. Through detailed study of bacteria and their evolution we can trace the origins of various innovative steps in the development of life on earth that contributed to this coping process. Margulis and Sagan (1997) write: *"In their first two billion years on Earth, prokaryotes continuously transformed the Earth's surface and atmosphere. They invented all of life's essential, miniaturized chemical systems (…). This ancient biotechnology led to the development of fermentation, photosynthesis, oxygen breathing, and the removal of nitrogen gas from the air"* (p.29). These innovations can be seen as effected by three dynamics (Margulis and Sagan, 1997, p.29-31), namely (1) DNA as an orchestrating substance; (2) the transfer of genetic material between bacteria; and (3) symbiosis. *"At one time, the ancient bacteria had combined with other micro organisms. They took up residence inside, providing waste disposal and oxygen-derived energy in return for food and shelter. The merged organisms went on to evolve into more complex oxygen-breathing forms of life. Here, then, was an evolutionary mechanism more sudden than mutation: a symbiotic alliance that becomes permanent"* (Margulis and Sagan, 1997, p.31). Research suggests that these dynamics, combined with the threatening pressures of changing circumstances on the earth over a period of three-and-a-half billion years, have contributed to the development of the diversity of life forms that we know today, including Homo sapiens. Levine (2002) points out the importance of genetic transfer in the development of capabilities: *"Many strengths and weaknesses appear to be inherited – either completely or in part. (...) often when a child has a particular kind of learning weakness, much the same pattern will be plainly evident in one or both parents or else in a sibling." (p.38)*

On the other hand, in order to survive, life has developed conservatism next to dynamics and inventiveness. *"To be alive, an entity must first be autopoietic – that is, it must actively maintain itself against the mischief of the* *world. (...) But even the predecessors to cells must have had some sort of autopoiesis, the ability to maintain their structural and biochemical integrity in the face of environmental threats"* (Margulis and Sagan, 1997, p.56). Reflection on the inventing, diversifying and conserving capacities of life leads Margulis and Sagan to the following conclusion on the evolution of life: *"Since autopoiesis is an imperative of the biota as a whole, life will expend huge quantities of energy to preserve itself. It will change in order to stay the same"* (Margulis and Sagan, 1997, p.66).

Man has been one of the outcomes of this evolution. He appeared at the scene relatively recently in the history of life on earth, after evolution had gone through many steps over a long period of time. Kroeber writes: *"A number of major achievements had to be made in the development of life before there could be man. (...) It is his significant antecedents that count. These are features which we are likely to take for granted: things like heads, legs, senses, nervous system, body heat; like the capacities for play, for sleeping, for living long enough to learn, and for dwelling together in societies. (...) They were not here when life began on earth. (...) They were developed haltingly, partially, one-sidedly, (…)"* (Kroeber, 1948, p.14-15).

These scholars clarify that creativity and innovation are not restricted to fully developed Homo sapiens. They were already present in the simplest life forms and are still found in the biological processes of human cells.

Social and cultural roots of creativity and innovation

At some point, men started to develop cultures. The anthropologist Kroeber (1948) defines culture as follows: *"Now the mass of learned and transmitted motor reactions, habits, techniques, ideas, and values – and the behaviour they induce – is what constitutes culture"* (p.8). Geertz (1973), however, seems to focus in his definition of culture on a part of the definition by Kroeber, and sees the concept of culture as: *"(...) an historically transmitted pattern of meanings embodied in symbols, a system of inherited conceptions expressed in symbolic forms by means of which men communicate, perpetuate, and develop their knowledge about and attitudes toward life*" (p.89). Kroeber additionally sees culture as based on biological, psychological and social processes and their development in time. According to the following description by Kroeber (1948), culture is socially constructed by groups of men. *"Culture, then, is all those things about men that are more than just biological or organic, and are also more than merely psychological. It presupposes bodies and personalities, as it presupposes men associated in groups, and it rests upon them; (...)"* (p.8) *"(...) from the angle of organic evolution, which means change in heredity, the* *increment or mutation that first introduced the capacity for culture was a very small increment. (...) the innovating or mutant individual manifested a new inclination to communicate, to learn and to teach, to generalize from the endless chain of his discrete feelings, actions and experiences. And therewith he began to be able to act as a receiver and a transmitter, and to begin the accumulation that is culture"* (p.71).

The economist Henry George sees economy and civilization, which I regard as cultural phenomena, as springing from the natural conditions of humans. He writes (George, 1932): *"(…) man differs from other animals in being the producer. (…) But while the animals get their food by taking what they find, (…) man has the power of getting his food by bringing it into existence."* (p.16-17) *"Yet at best, man's individual powers are small and his life is short. (...) But man is more than an individual. He is also a social animal, (…). It is in this line of social development that the great increase of man's knowledge and powers takes place. (...) The rise of civilization is the growth of this co-operation and the increase of the body of knowledge thus obtained and garnered."* (p.19) *"It is this natural system or arrangement, this adjustment of means to ends, of the parts to the whole and the whole to the parts, in the satisfaction of the material desires of men living in society (...) which is the economy of human society (...)"* (p.20).

To Kroeber's and George's observation that culture springs from biological conditions, the view of Geertz (1973) can be added that *"(...) there is no such thing as human nature independent of culture."*, because: *"As our central nervous system grew up in great part in interaction with culture, it is incapable of directing our behaviour or organizing our experience without the guidance provided by systems of significant symbols. (...) Such symbols are thus not mere expressions, instrumentalities, or correlates of our biological, psychological or social existence; they are prerequisites of it. (...) Without culture, no men"* (p.49). This statement implies that there is a mutual influence between cultural and biological phenomena. This means that human capabilities influence the development of cultural elements and that these capabilities are also influenced by culture. To this can be added the following finding of Paillet (2006) on the development and meaning of prehistoric art: *"One can say that art is rooted in a very old biological substrate and that at a certain moment it becomes essential for the communication systems between people. These systems densify with progressive population growth and the social and economic disintegration of groups of hunter-gatherers. Art is also a very good way for a person to confirm his membership of a group, his social status, even his power"* (Paillet, 2006, p.16). *"Taking into account the diversity of the applied materials (quarts, sandstone, flint, jasper, bone) and forms of the end product (disc-shaped, oval,* *triangular) the production of hand-axes, during hundreds of thousands of years, has not always been led by material or functional needs (firmness, effectiveness). This search for the purity of forms makes us think that long before the arrival of figurative art, humans had already worked out abstract mental schemas that are at the origin of art"* (Paillet, 2006, p.19-20).

Related to the development of man's faculty to communicate, learn and teach in social settings may have been the development of new inventive capabilities, dependent on social contacts, to devise complex production systems and subsistence strategies. Kroeber (1948), Paillet (2006) and Boden (2004) suggest that: *"(...) many inventions are not single acts of mind, but cumulative results. They are social events, and therefore they usually are gradual events"* (Kroeber, 1948, p.361-362). *"The development of modern human communities is at the origin of the most innovative symbolic behaviours. The systems for the expressions and graphic communication that have been invented and structured in accordance with systematic norms at the beginning of the upper Paleolithic, are completely new and original"* (Paillet, 2006, p.23). *"The origin and long-term survival of an idea, and the extent to which it is valued and disseminated at any given time, depend on many different things. Shared knowledge and shifting intellectual fashions are especially important (…). But other factors are relevant, too: loyalties and jealousies, finances and health, religion and politics, communications and information storage, trade and technology"* (Boden, 2004, p.45).

As we wrote in Van Kleef and Roome (2007a), relationships and cooperation are essential to the productivity of ideas. Specific local natural environments have always provided people with certain possibilities for agriculture, hunting, nomadism, seafaring or industry. They also forced the development of specific capabilities to survive under a range of circumstances. Sprouting from these, and linked with the growth of different professions, relationships, trades, networks of customers and suppliers, was the development of professional languages, habits, traditions, societies, tools, products, services, folklore, art, forms of education, and so on. Paillet (2006) illustrates this when he writes: "*Cro-Magnon ingeniously takes advantage from the inexhaustible reserves of hard organic materials (bone, wood, (…) ivory) that nature provides. Grinding and working the primary materials he mobilises techniques and new technologies that he immediately puts to the service of his insatiable needs. He creates new tools, each time better adapted to his diverse activities as a craftsman, hunter-fisher and gatherer (bodkins, chisels, needles, polishing stones, coils, …) (…)" (*Paillet, 2006, p.21). And *: "One has to take an environment into account that evolves and that not always offers the same* *reception. Cro magnon adapted himself and responded with a strong social organisation, built on communication between groups, and certainly with a progress in language that was unmatched"* (Paillet, 2006, p.23).

Socially constructed formal and informal institutions influence the possibilities for and the outcomes of collaboration between people and organizations (Gössling, 2005). All that is learned, taught and produced constitutes specific cultures and sub-cultures, and provides people with various cultural orientations (Binsbergen, 1999; Kroeber, 1948). Levine (2002) stresses the various ways in which culture influences human development: *"A student's cultural background may help determine which neurodevelopmental strengths get stronger and which ones do not."* And*: "Socio-economic realities exert powerful influences on a child's development"* (Levine, 2002, p.39).

The influence on the development of human creativity and innovation by interacting biological, social, cultural and (cross-cultural) genetic factors is illustrated by Caspari (2011) in their reconstruction of the development of longevity and cultural changes in human civilization in the Upper Paleolithic, and by Goleman and Boyatzis (2011) in their research on the biological influence of leaders on the participants in groups.

Innovation processes as intercultural and naturally occurring struggles. Design suggestions for management for sustainable development.

The differences between the cultural orientations of (groups of) people create differences in worldviews and interests, and these are sources of tensions and conflicts in and between groups. These tensions and conflicts may promote or inhibit the capacity for creativity. The struggle between conflicting desires and views in a society, and the influence of this struggle on the full development of human talents, inventiveness and morality, has been of interest for many years. An example of intercultural cooperation and its effects in ancient Egypt is given by Trigger, Kemp, O'Connor and Lloyd (1998, p.67). *"Around the beginning of the First Dynasty, however, the kings of Egypt started to provide work for an increasing number of specialists on a full-time basis. As the Egyptian State grew, the court and the official hierarchy expanded, providing a larger market for specialized goods and services and this, in turn, facilitated a high degree of specialization within particular lines of work. One result of this specialization was a marked increase in the quality of what was being produced. (…) One effect of this control of production by accountants and administrators must have been to discourage innovations, once acceptable modes of production had been worked out. (…) once a solution had been evolved, development ceased and a new convention was added to a stockpile of existing traditions*."

Fromm (1990) presents the view that the need for creative expression is fundamental and paradoxical for creative individuals. He suggests that room for creativity requires the recognition of individuality in a team, yet this creates tension with the need of the creative individual for connectedness with his/her colleagues. The effects of this tension between exceptional, creative individual, and collaborative behavior in teams or wider groups provide the basis for innovative thinking. In other words, creativity is a natural expression of individuals but it is harnessed and/or inhibited within groups and requires strong teamwork and individual and collective esteem.

The issue of how natural creativity is repressed and/or supported is discussed by Fromm (1990). He proposes that oppressive managerial methods cause people's inventive skills to decrease. And Dewey (1997b) shows that formal discipline in education harms native inventive and exploration skills because it exerts… "*(…) undue emphasis upon the training of narrow specialized modes of skill at the expense of initiative, inventiveness, and re-adaptability qualities which depend upon the broad and consecutive interaction of specific activities with one another*" (p.68). Both authors identify that natural, fundamental inventive capacities are often blocked through restrictive management approaches and structures, and that this contributes to the problems that many adults experience with innovation processes in organizations. Indirectly, the blocking of inventive capacities contributes to social problems in our society through feelings of not belonging, unhappiness and frustration.

Immanuel Kant (1784) argued that conflicting desires are a normal part of a useful and natural struggle that fuels the progress of society: *"Man has a propensity for living in society, for in that state he feels himself to be more than man, i.e., feels himself to be more than the development of his natural capacities. He also has, however, a great tendency to isolate himself, for he finds in himself the unsociable characteristic of wanting everything to go according to his own desires, and he therefore anticipates resistance everywhere, just as he knows about himself that for his part he tends to resist others. Now this resistance awakens all of man's powers, brings him to overcome his tendency towards laziness, (…) In this way, the first true steps from barbarism to culture, in which the unique social worth of man consists, now occur, all man's talents are gradually developed, (…)." "Man wills concord; but nature better knows what is good for the species: she wills discord(…)"* (p.32). Yet Kant indicates that this struggle can only lead to optimal results if it is checked by laws that safeguard freedom for all: *"Since it is only in society—and, indeed, only in one that combines the greatest freedom, and thus a thoroughgoing antagonism among* *its members, with a precise determination and protection of the boundaries of this freedom, so that it can coexist with the freedom of others (…). Thus must there be a society in which one will find the highest possible degree of freedom under external laws combined with irresistible power, i.e., a perfectly rightful civil constitution"* (p.33). This matches with research by Gössling (2007) that indicates that *"…the legal institutions of a society are important for the possibility of collaborating at all"* (p.35).

These comments on the role of law can be related to creativity and innovation in businesses working in collaboration with other social actors on the project of sustainable development. It suggests that the collaborative process itself, under rules that enforce freedom for all its participants, might serve as an institutional mechanism to sanction creativity and innovation that brings benefits that are more sustainable, while also serving as a limit to those creative acts that are not sustainable (adapted from Van Kleef and Roome, 2007b).

This view is supported by the research of Stiglitz (2001, 2002). His theory of asymmetric information explains market imperfections and their economic and social costs, and it provides the foundations for government policies that promote open, transparent and participatory processes on all levels in society in order to enable sustainable development: *"The owners* [of a company – Hvk] *(…) not only could not monitor their workers and managers (…), because of the asymmetrics of information, they typically did not even know what these people who were supposed to be acting on their behalf should do"* (Stiglitz, 2001, p.509-510). *"(…) open, transparent, and participatory processes are important ingredients in the development transformation – important both for sustainable economic development and for social development (…)"* (Stiglitz, 2002, p.175). *"No institution, whether domestic or international, has a monopoly on wisdom, and it is imperative that there be a full articulation of the evidence concerning the consequences of alternative policies"* (Stiglitz, 2002, p.177).

Overview of factors influencing the development of capabilities for creativity and innovation

The picture that arises from diverse research papers presented in this section is that the development, the expression and thus the practical results of the human creative drive and his/her capabilities to innovate can, in general, be seen as being determined by six groups of aspects that mutually influence each other. I suggest that these six groups are at the basis of the structures and processes that I identified in 3.3, namely those of networking, coalition and relationship building, collaborating, systemic thinking, inventing unknown options, combining and integrating different innovations and problems, and learning.

A. Biological and physical aspects: the development of life on earth through genetic recombination and symbiosis, in interaction with changes in the natural environment (Margulis and Sagan, 1997; Kroeber, 1948; Paillet, 2006; George, 1932). This group provides us with highly personal, stronger or weaker, natural, inborn creative and social drives and capabilities to innovate (Fromm, 1990; Dewey, 1997a; Boden, 2004; Kant, 1784; Levine, 2002).

B. Social aspects: the development and characteristics of human social relations, as a basis for cooperation, learning and the exchange and recombination of knowledge (Kroeber, 1948; Levine, 2002; Fromm, 1990; George, 1932; Paillet, 2006) in processes of social construction (Pinch et al., 1989).

C. Cultural aspects: the development of different human cultures representing specific bodies of knowledge, lifestyles, experiences and capabilities (Dewey, 1997b; Kroeber, 1948; Geertz, 1973; Levine, 2002; Kant, 1784; Paillet, 2006).

D. Inter- and cross-cultural aspects: the characteristics of (genetic) interactions between people from different cultures (Kroeber, 1948; Levine, 2002). These provide ground for new combinations of knowledge and new directions of learning and development.

E. Structuring aspects: the rules, laws and organizational structures governing social, professional and intercultural relations and interactions between actors (Kroeber, 1948; Kant, 1784; Geertz, 1973; Stiglitz, 2001, 2002). These influence the degree to which the development of creativity is facilitated in social constructionist processes of networking, coalition and relationship building and collaborating.

F. Historical, dynamical, process aspects: the concrete development in time and interactions within and between the aspects A to E above.

3.6 Research agenda: Questions to be answered for development of the competence of innovation for sustainable development

Above, I have reviewed the literature on innovation by firms directed toward competitiveness and then sustainable development. I have reviewed related literature in the field of (inter-)organizational learning and dynamic capabilities, and contemplated on the connections between innovation and organizational learning processes. And I have reviewed literature on capabilities to discover unknown options and to collaborate under diversity,

There is a body of literature that highlights the capabilities needed for innovation that is driven by competitiveness (Strong, Ringer and Taylor, 2001; Doz et al., 1997; Edquist, 1997; Foray, 1997; Tushman and O'Reilly, 1997; O'Reilly and Tushman, 2004; Hamel and Valikangas, 2003; Hargadon and Sutton, 2000; Nooteboom, 2000a; Volberda and Van den Bosch, 2004; Utterback, 1996). Here it is argued that collaboration with different actors in networks contributes to the competence to innovate for reasons of competitiveness.

I compared this literature with literature that focuses on the development of the competence for innovation towards sustainable development. This too requires collaborative innovation through networks and multi-actor forums at many levels, including the local level. I found literature that described the capabilities that contribute to competence in innovation for sustainable development (Sweet, Roome and Sweet, 2003; Roome, 2001a and 2001c; Rip, Misa and Schot, 1995; Wynne, 1995; Herbold, 1995; Hawk, 1995; Remmen, 1995; Jelsma, 1995; Partidario and Vergragt, 2002).

Comparison of the two bodies of literature suggests that the capabilities show significant overlap and are deployed through similar structures and processes of networking, coalition and relationship building, collaborating, systemic thinking, inventing unknown options, combining and integrating different innovations and problems, and learning.

However, the comparison also indicates that for innovation towards sustainable development (that strives for systems change) capabilities with a different character need to be developed in order to deal with a wider variety of actors (including local actors) than is found in innovation for competitive reasons. This raises concerns about the challenge of establishing trust and commitment for innovation, especially given the tension between the sharing and the appropriation of knowledge (Roome, 2001c; European Commission, 2001; Foray, 1997). I also found that in both bodies of literature scant attention is paid to methodical ways that teams, organizations and inter-organizational structures can use to invent new options, for example, technologies that arise from the need for new solutions, new products, production processes or new business models. Considering the importance of invention in innovation for competitiveness and sustainable development, I see this as a serious omission.

The recommendations for further research that I identified in recent literature in the fields of innovation, sustainable development, (inter-)organizational learning and dynamic capabilities support the challenge of innovating for greater sustainable development with a wide variety of actors and the need for new know-how to facilitate learning processes.

First, recommendations were identified for more empirical research (Sambrook and Roberts, 2005; Dasgupta and Gupta, 2009; Jiménez-Jiménez and Sanz-Valle, 2010; Sanz-Valle et al., 2001; Nooteboom, 2006; Schiederig et al., 2012; Frishammar et al., 2012; Smith et al., 2008; Van Huijstee et al., 2007; Klewitz and Hansen, 2001; Crutzen and Herzig, 2012; Haamann and Basten, 2012; García-Morales et al., 2006) to enable the development of models that facilitate deeper insight into the factors, interrelationships and dynamics of inter-organizational learning for innovation and sustainable development.

Secondly, and connected to this challenge, recommendations were identified to research the critical underlying managerial, contextual and processual factors (Siebenhüner and Heinrichs, 2010; Smith, 2012; Lampela, 2009; Rondeaux et al., 2009) and the development of dynamic capabilities (Wang and Ahmed, 2007; Easterby-Smith, Lyles and Peteraf, 2009; Di Stefano, Peteraf and Verona, 2010; Barreto, 2010; Harris, Kaefer and Salchenberger, 2013; Narayanan and Douglas, 2009; Ramachandran, 2011; Swift and Hwang, 2008).

I concluded by presenting an overview of the capabilities that contribute to the organizational competences to discover new options and to collaborate in highly diverse teams. I discussed ideas drawn from the presently rather fragmented body of knowledge about the formal and informal organizational factors that enable the development of these capabilities. And I presented a review of the factors that form the roots of human creative and innovation capabilities.

The literature researches and comparisons have led me to suggest a number of areas for further research in the field of management.

<u>Management Research Agenda</u>

In terms of the process of innovation within companies and networks involving companies, research is needed that addresses our understanding of the development of capabilities for participative learning and innovation for sustainable development. In particular:

- How do capabilities in managers that support innovation for sustainable development differ from those that support innovation for economic reasons?
- How do we recognize the capabilities in managers that build the competence of systematic inter-organizational learning and collaborative innovation for sustainable development? No research was found on this subject, except for the identification of the significant role played by the information processing and decision styles of team members involved in innovation reported by Sweet, Roome and Sweet (2003).
- How do managers and others in possession of competence in inventive thinking and other capabilities develop these, and how do they develop the capacity to manage and take specific roles in learning processes for innovation?
- How might companies recognize these capabilities in managers so that they can consciously develop their organization, teams, networks and collaborations with the requisite set of roles and capabilities?
- To what extent do they each need to be present in a team or network or organization to enable inter-organizational learning for sustainable development to flourish?
- How might organizations seek to systematically develop these capabilities and roles among managers through development programs, training or work experience? How might organizations develop their capacity for consistent inter-organizational learning?
- How do these capabilities fit together in ways that build dynamic capabilities to systematically develop innovations for sustainable development in dynamic multi-actor situations that are new to the participants and characterized by complexity and a lack of knowledge?

Methodical Issues

In the case of management research, there are critical issues about the way to study and model the development and deployment of these capabilities and competences in any given company or network. How might the key capabilities, roles and development processes be observed, measured and explained? Their development through experience implies the need for longitudinal, historical or event studies that track changes in potentially tacit skills.

In the absence of empirical studies it is difficult to construct conceptual and normative models of dynamic, multi-actor processes of inter-organizational learning, and of the way to combine the blend of capabilities and roles for business management towards sustainable development. This is especially problematic given the many varying contexts within which such models would need to be applied. In the absence of such a model or models it is unclear as to how learning and innovation practices in teams, networks, organizations and clusters of organizations might be improved in a consistent manner.

In my opinion, research on these issues makes a valuable contribution to the body of knowledge on business management towards sustainable development. It contributes to building a body of theory of systematic innovation for sustainable development. This would help to develop education and organizational development programs that foster the capabilities for moving towards sustainable development, and to guide companies and public policy in a transition towards more sustainable patterns of production and consumption.

3.7 Research questions

In this section, I formulate the research questions that seem to be most relevant, accompanied by sub-questions. They are based on the general problem description in section 1.4, the main findings from my study of the characteristics of innovation processes in section 2.3, and the literature research and research agenda in chapter 3. I summarize these findings as follows:

Innovation in business needs to be innovated in order to consistently contribute to more sustainable development. Science can contribute to this challenge, provided it is tuned to the empirical situations of companies. These situations are characterized by a systemic nature with multi-actorship, complexity, dynamic development in time and a lack of knowledge and overview. By taking these characteristics into account, science may be able to develop theory and conceptual and normative models that may help to systematically develop practical improvements. To facilitate that effort, it is helpful to understand how innovation processes in projects for competitive purposes, and in those aimed at greater sustainable development, differ. It is also useful to understand how these differences are influenced, e.g. by the learning processes of the actors, by the competences of companies, by the contributions and capabilities of managers, and by business processes and other factors.

The stated aim of the research (section 1.5) and the literature research (sections 3.2 – 3.5) help to distinguish four main aspects of multi-actor innovation projects. With these aspects I achieve a first ordering of the interview data, and they will act as lenses through which I can analyze the research.

The first aspect is that of the managerial capabilities and their development. These capabilities are seen as influential in the organization, management and execution of innovation processes, in the development of organizational competences, and in the courses and outcomes of innovation projects. Impressions of these capabilities can be gathered through interviews.

The second aspect concerns the innovation processes in the projects. These processes are seen as expressions of managerial capabilities, learning processes and dynamic capability. Information on their courses and characteristics can be gathered through interviews.

The third aspect consists of the actors, teams or networks. In all literature that I reviewed, the networks, teams and collaborations between actors are seen as important elements of innovation, because innovation projects are connected with customers, suppliers and other actors in and outside companies.

The fourth and last aspect that I distinguish is the dynamics between these aspects in a systemic setting. These dynamics arise as an innovation project develops over time.

The design of the research questions, the data analysis and the synthesis of conclusions are performed from the perspective of modeling the management of learning in dynamic, (inter-)organizational situations that develop over time. By specifying these themes and the perspective, I mean to follow the advice of Leonardo da Vinci (Richter, 1970a): *"Those who are in love with practice without knowledge are like the sailor who gets into a ship without rudder or compass and who can never be certain whether he is going. Practice must always be founded on sound theory, and to this Perspective is the guide and the gateway; and without this nothing can be done well in the matter of drawing"* (p.18).

On the basis of the identified aspects and the research agenda, I designed three main research questions, of which question 1 is accompanied by sub-questions a to g.

1. What was the role of managers in the processes of innovation and learning in the innovation projects, and to what extent and in which way did these processes contribute to the development of changes for greater sustainable development?

   Sub-questions regarding managerial capabilities

   1.a How did managers and others contribute to the projects?

   1.b Which capabilities did they apply?

   1.c How did they develop these capabilities?

   Sub-questions regarding the innovation processes

   1.d Which innovation processes can be discerned?

   1.e How was the discovery of new options given form?

   Sub-questions regarding the different actors, teams or networks

   1.f What was the role of the actors from the different networks?

2. How were the managerial capabilities, the innovation processes, the teams, the network and the project outcomes related to each other?

3. Which dynamic capabilities for innovation and sustainable development can be distinguished?

3.8 Concluding remarks

On the basis of the literature research, I have identified 4 main critical observations in this chapter that prevent a deeper understanding of inter-organizational learning for innovation and sustainable development:

1. *Lack of attention to the development of methods and capabilities for discovering unknown options (…) especially given the importance of inventiveness in the development of sustainable options.*

2. Lack of insight into the *capabilities (…) to accommodate these very diverse perspectives while operating within a multi-organizational system that is sensitive to locality*.

3. *The lack of empirically grounded models that take into account the dynamics and systemic complexities of inter-organizational learning processes for sustainable development does not help policy makers and*

managers to picture, understand and systematically facilitate these processes in practice and realize consistent progress towards sustainable development.

4. *Research that provides deeper insight into the factors that have a critical influence on the quality of empirical inter-organizational learning processes and of the development of dynamic capabilities contributes to the design of more dynamic models for systematic learning for innovation and sustainable development*.

A second literature research mapped the main factors that contribute to the history and roots of human creative and innovation capabilities: biological and physical aspects, social aspects, cultural aspects, inter- and cross-cultural aspects, structuring aspects and historical, dynamical, process aspects.

On the basis of the critical observations and literature research, a research agenda was constructed and four main aspects of innovation projects were found. These formed the basis for the three main research questions in section 3.7.

Next, in chapter 4, I will sketch my research philosophy and methodology, as an introduction to the research data, the analysis and cross-case analyses, and the synthesis into the answers to the research questions, a conceptual development model and the conclusions.

4 Research philosophy and method

4.1 Introduction

In chapter 3, I presented the literature research, critical observations and three major research questions for empirical research of innovation processes in company projects. These questions are:

1. What was the role of managers in the processes of innovation and learning in the innovation projects, and to what extent and in which way did these processes contribute to the development of changes for greater sustainable development?
2. How were the managerial capabilities, the innovation processes, the teams, the network and the project outcomes related to each other?
3. Which dynamic capabilities for innovation and sustainable development can be distinguished?

To clarify my research approach, in section 4.2 I present the research philosophy that functions as the starting point for the construction of the research method, which is presented in 4.3. In Appendix I, the research protocol and the questionnaire that I used in the interviews are presented. In the next chapter, the Dutch paper and board producing sector will be introduced.

4.2 The research philosophy

In this section, I describe my view on the role of academic research in improving sustainable development. I describe how I see the role of company practices in my research, and the perspective from which I approach the diversity and dynamics that are present in these practices. I then elaborate on the role of theory.

The role of academic research

In my view, an important task of academic research is to increase our understanding and knowledge of the world, of its biological, physical, social and cultural workings, and its problems, as a contribution to the development of life on earth. The analysis in chapter 1 shows that the challenge of sustainable development is of such immense importance and magnitude that human society needs all the means available to it to tackle it effectively. I see it as my role to design this research in a manner that will help to improve in practice the development of capabilities and competences for systematic innovation for sustainable development. Therefore, my research method is designed to carefully maintain a close relationship between actual company practices and the final recommendations.

The role of company practice and its diversity

I chose to research the practice of innovation in companies for reasons that three great thinkers on learning and innovation, Leonardo da Vinci, René Descartes and John Dewey, expressed clearly when they wrote the following:

"(...) since good judgement is born of clear understanding, and a clear understanding comes of reasons derived from sound rules, and sound rules are the issue of sound experience – the common mother of all the sciences and arts" (Richter, 1970a, p.18).

"For these reasons, as soon as my age permitted me to pass from under the control of my instructors, I entirely abandoned the study of letters, and resolved no longer to seek any other science than the knowledge of myself, or of the great book of the world. I spent the remainder of my youth in travelling, in visiting courts and armies, in holding intercourse with men of different dispositions and ranks, in collecting varied experience, in proving myself in the different situations into which fortune threw me, and, above all, in making such reflection on the matter of my experience as to secure my improvement" (Descartes, 1637).

"Words, the counters for ideals, are, however, easily taken for ideas. And in just the degree in which mental activity is separated from active concern with the world, from doing something and connecting the doing with what is undergone, words, symbols, come to take the place of ideas. The substitution is the more subtle because some meaning is recognized. But we are very easily trained to be content with a minimum of meaning, and to fail to note how restricted is our perception of the relations which confer significance. We get so thoroughly used to a kind of pseudo-idea, a half perception, that we are not aware how half-dead our mental action is, and how much keener and more extensive our observations and ideas would be if we formed them under conditions of a vital experience which required us to use judgment: to hunt for the connections of the thing dealt with" (Dewey, 1997b, p. 144).

Observing present developments in business practice, I see a great diversity in the efforts aimed at achieving sustainable development. Furthermore, I observe that the systems of production and consumption in practice are in constant development, and that the participants in these systems interact dynamically with each other. My observations of diversity and dynamics lead me to the following points of departure for my research:

Limited generalization potential of empirical research

This empirical research is limited in its scope, size and time frame, and in the light of the diversity and dynamics of company practice its conclusions can be considered valid only in relation to the cases researched. However, increasing our understanding of a limited number of cases helps us to deepen our understanding of efforts to realize sustainable development, and helps researchers to effectively design further research. As Wittgenstein writes (1965, pp. 19-20): *"The idea that in order to get clear about the meaning of a general term one had to find the common element in all its applications has shackled philosophical investigation; for it has not only led to no result, but also made the philosopher dismiss as irrelevant the concrete cases, which alone could have helped him to understand the usage of the general term."* Generalization of the outcomes of the research to other projects or companies is only possible after analysis has demonstrated that the aspects, influential factors and developments in these projects are comparable with the ones outlined in this research.

The data is not the project

In case studies, the researcher collects data by interviewing, studying documents or observing actions of people. But it is important to differentiate between an account of a project, consisting of words and pictures that represent specific perspectives, and the actual historical development of the project itself. In this I follow Wittgenstein (1922) and Geertz (1973): *"(...) – that what we call our data are really our own constructions of other people's constructions of what they and their compatriots are up to - (...)". "Analysis, then, is sorting out the structures of signification (...) and determining their social ground and import"* (Geertz, 1973, p.9). From this line of reasoning, I recognize the limits to the possibility of structuring cause and effect relations with any certainty. As Wittgenstein suggests (1965, p.15): *"The proposition that your action has such and such a cause is a hypothesis. The hypothesis is well-founded if one has had a number of experiences which, roughly speaking, agree in showing that your action is the regular sequel of certain conditions which we then call causes of the action. (...) Of the cause one can say that one can't know it but can only conjecture it."* Based on this differentiation between the actual case and the data on the case, I see diversity in interviewees and documents as useful in collecting a multitude of data that help me to construct a multi-sided description of the case, its actors and their relationships, and to construct well-founded hypotheses.

Cultural orientations determine meanings

The fact that in an innovation project actors are involved who have various (professional) backgrounds means that various (professional) cultural orientations are also involved (Binsbergen, 1999). A consequence of cultural diversity is that, although people may be speaking the same language, differences in the meaning of words used may exist, and that common, stable and clear meanings cannot be presupposed. Furthermore, it is the specific common culture in the company or the project team that gives a situation and an innovation project its specific meaning. For example, one consequence of an unstable meaning of the terms *sustainable development, innovation* and *innovation for sustainable development* in the diverse company practices is that I cannot base the research on a common understanding of sustainable development and innovation. As Pinch and Bijker suggested *(*1989): *"In deciding which problems are relevant, the social groups concerned with the artefact and the meanings that those groups give to the artefact play a crucial role; A problem is defined as such only when there is a social group for which it constitutes a 'problem'"* (p.30). I see this research as being partly anthropological and partly ethnographical, and I follow Geertz (1973) who writes: *"The important thing about the anthropologist's findings is their complex specificness, their circumstantiality. It is with the kind of material produced by long-term, mainly (though not exclusively) qualitative, highly participative, and almost obsessively fine-comb field study in confined contexts that the mega-concepts with which contemporary social science is afflicted – legitimacy, modernization, integration, conflict, charisma, structure, ... meaning – can be given the sort of sensible actuality that makes it possible to think not only realistically and concretely about them, but, what is more important, creatively and imaginatively with them"* (p.23). And*: "The essential vocation of interpretive anthropology is not to answer our deepest questions, but to make available to us answers that others (...) have given, and thus to include them in the consultable record of what man has said"* (p.30).

Innovation projects are developed in social construction processes

The diversity that is evident in actors and stakeholders, in cultural orientations and in practices in innovation projects, leads to a dynamic development of these projects over time. This development is characterized by interaction between actors who have different interests, ambitions, knowledge, capabilities and views on situations. Following Bijker (1989) I view these interactions as socially determined construction processes that realize the development of innovation projects and in which "*(…) people construct their cognitive categories, or mental models, by which they perceive, interpret and evaluate phenomena*" (Nooteboom, 2006, p.3). As Pinch and Bijker propose *(*1989): *"There is not just one possible way or one best way of designing an artefact. In principle, this could be demonstrated (...) by interviews with technologists who are engaged in a contemporary technological controversy"* (p.40). And: *"It can be shown that different social groups have radically different interpretations of one technological artefact. We call these differences "radical" because the content of the artefact seems to be involved"* (p.41). And: *"To close a technological "controversy", one need not solve the problems in the common sense of that word. The key point is whether the relevant social groups see the problem as being solved"* (p.44).

In addition to this, the view of Kant can be added, who stressed that opposing powers in processes of social interaction are the basis of talent development and progress (Kant, 1784, thesis 4-7).

<u>The role of theory</u>

In general, I see theory as an aid to understanding and further developing practice. With this research, I aim to assist the expansion of theory and help develop its relation to practice in order to diminish the gap between theories on sustainable development on the one side, and concrete policies, action plans and work methods on the other. My focus is therefore on further theory development, and not on any verification of hypotheses or theory.

I have used existing theory in three ways to assist me in the research. I examined literature in order to draw up an inventory of the capabilities for innovation that are suggested in theory and on the basis of past research. Secondly, based on the literature, I formulated critical observations to guide the specific focus of my research. And thirdly, I examined literature from the fields of cognitive science, geosciences, anthropology, psychology, sociology, education and philosophy which, when combined, present a view of the history and roots of human creative and innovation capabilities. I thus used theory to develop my research perspective (section 3.3), to extend the ground from which insights may spring, and to compare my findings.

4.3 The research method

In this section, I present the research method. I clarify my use of a combination of a deductive and an inductive approach, and I explain the choice to do case study research. I clarify the interview method and the units that I have chosen for my analysis. I present the methods of data verification, structuring and analysis, and I explain the role of the tool *ATLAS.ti* in this.

The combined deductive and inductive approach

The research method that seems best suited to my aim, the research philosophy and the identified critical observations is a combination of a deductive and an inductive approach. I deductively construct the main broad insights on innovation processes from existing literature. These help me to order the large amount of interview data that, because of my use of the narrative interview technique, cover many different and interrelated subjects. Supported by this first ordering of data, I then reconstruct the details, dynamics and interrelationships between the different factors that according to the interviewees have influenced the courses of events and the outcomes of the projects. Analyzing these, I inductively reach insights regarding the processes of learning and innovation. The combination of a deductive and an inductive approach enables me to construct a conceptual model that is anchored both in existing theory and in empirical data.

The reasons for my choice to use a combination of a deductive and an inductive approach are the following: The field of learning for innovation processes for sustainable development is relatively new, both in company practice and in the academic world. This means that there has not been much empirical research that through induction supports theories that are mature enough to justify the confident deduction of testable hypotheses. The approach partly supports inductive theory development that fits with the present lack of knowledge regarding innovation and sustainable development, and that also applies current main theoretical insights.

Furthermore, I strive to contribute to theory development that helps me understand deeper concrete situations, to remain close to the research data, and to develop recommendations that closely fit business practices and existing theories.

Case study research

I chose to do case study research for the following reasons, based on the work of Yin (2003). The research focuses on contemporary events for which data cannot, in general, be found in documents, artifacts or archives. The people involved in the events are still alive and can be contacted. The fact that the research questions are open, semi-structured and generate lengthy answers, means that the data can be best collected through interviews as part of a case study, instead of through historical research, archival analysis or a survey. As I am an outsider who is researching innovation processes in company projects, I cannot control the events that I am researching. It is impossible for me to collect data from experiments. The last reason is that most of the research questions are framed as 'how' questions. They are intended to explore innovation processes, the methods, capabilities or competences that have been applied, and the way these have been developed. I try to gain an understanding of the complex empirical, social and organizational phenomena and their development over time in situations where the boundaries between the phenomena and their context are not clearly evident. The questions *"…deal with operational links needing to be traced over time, rather than mere frequencies or incidence."* (Yin, 2003, p.6), which makes them suitable for case study research.

The interview method

The interviews focus on the reconstruction of the histories of four innovation projects. I use the Narrative Interview technique developed originally by Schütze (1977). It uses few and open-ended questions that are meant to invite the interviewee to talk freely about the case from his perspective. The method also uses a few further questions to invite the interviewee to go more into more detail on interesting subjects that arise from his narrative. This technique leads to detailed accounts that are close to the events that took place, that focus on themes that the interviewee considers important or relevant, and that cover the events researched from their beginning to their end (Jovchelovitch and Bauer, 2000; Schütze, 1977). I chose to use the Narrative Interview technique because it was my aim to avoid steering the interview with closed questions designed from my own perspective or with assumptions and opinions about the case, thereby implicitly selecting the data that would be presented to me.

However, there is a risk connected to using the data collected in retrospective, narrative interviews. As the research focuses on past projects, interviewees will already have reflected on the course of events and constructed their own story. It is possible that these stories convey a logical line and causal relationships that have been infused by their reflecting upon them after the event, by which they may have created a socially accepted picture that leaves out events that do not fit in and that uses currently accepted terminology in its expression. Therefore, these stories probably do not show all that has actually happened. I intend to increase the chances of uncovering diverging perspectives and events that do not fit the dominant stories by interviewing all of the actors who played a significant role.

The units of analysis

The units of analysis are the innovation processes that the case studies of four clearly outlined projects represent. This choice is motivated by my intention to gain an insight into the historical development and dynamics of complete innovation processes in companies and in the main aspects that have influenced these processes, rather than an isolated overview of the role of certain individuals, functions or sub-processes. The research uses four units of analysis (the innovation processes in four innovation projects in three companies) and compares these with each other.

Method of data verification. Composition of the narratives

In total, 30 interviews were planned, of which 28 have been realized. One person (a consultant) refused to be interviewed because he was afraid he might provide information that would benefit his competitors. With one other person (a foreign specialist employed abroad) a meeting could not be arranged due to changes in his travelling schedule.

Of the 28 interviews, 27 were recorded on tape. In one interview the recording device was set up incorrectly, so that recording did not take place. During and directly after the interviews, notes were taken. All interviews were transcribed in full and stored in the file of the case study that they belonged to. Then the following steps were taken.

First, in each case study, the answers from all interviewees to a question were compiled in separate files. Thus, in each case study the seven questions generated seven data sheets that each contained the answers of all interviewees to that question. I took special care to make sure that no fragments of interviews escaped entry into the data sheet. Then, for every case study I constructed a so-called *"thick description"* (Geertz, 1973) from the data sheets. This thick description contained all the material from the data sheets and pictured the innovation process in its logical sequence and context. This step resulted in four thick descriptions. Thirdly, every thick description was sent to the manager responsible for the innovation process, with the request to read it and check the validity of the data. Each description sent was approved and only a few minor corrections were sent back. This confirmed the validity of the descriptions and the underlying data. Finally, I condensed the approved but lengthy thick descriptions into shorter narratives, and I used these to introduce the case studies in chapter 7.

Data analysis
In the data analysis phase, I first saved all of the Word files with the transcribed interviews as txt-files and fed them into Atlas.ti software. This software has been designed to analyze and synthesize qualitative data. I used the first case study, the one on Rofire, to develop a work method for coding all of the text and to show, with the help of Atlas.ti network-view, the interrelationships between persons and activities, and the development of the project over time. This proved to be too ambitious: the number of codes exploded and the resulting network became too complex.

I then proceeded to mark all parts of each interview that concerned the different contributions of interviewees, the capabilities they applied, and the developmental factors of these capabilities. Thus, I was able to make the data more accessible for the analyses (chapter 7). I derived First Order Concepts, Second Order Themes and Aggregate Aspects, each time focusing on one of the main innovation themes identified in chapter 3.

Cross-case analyses, conclusions and recommendations
In chapter 8, I have compared the cases with each other. These cross-case analyses focus on the three aggregate aspects that the analyses showed to be influential in the projects. Based on the cross-case analyses, I distinguish the main factors that have influenced the outcomes of the projects and I compare the results of the analyses of the innovation projects for business and sustainable development with each other. In chapter 9, I present answers to the research questions and a synthesis of the findings in a conceptual developmental model. In chapter 10, logically derived theoretical propositions and recommendations are presented.

4.4. The selection of the cases

Here I explain the process of selection of the four cases that I have studied. I first clarify my choice for the paper and board producing sector, and then explain how I selected the three specific companies and four projects. I end with a description of the differences between the cases.

<u>The selection of the Dutch paper and board producing industry</u>

In the first half of 2005, I had finalized the research set-up and was ready for the next step: approaching companies with a request to cooperate in the research. The choice for the paper and board sector in The Netherlands was guided by two factors.

Through its use of wood fibers, energy and chemical processes, paper production is closely tied to the areas of pollution, climate change, the exhaustion of natural resources and the conservation of natural habitats. These areas are all related to sustainable development. Secondly, in the years 1999 – 2003, I had worked as a consultant with IMSA Amsterdam, an institute for environmental and systems analysis. In that position I had worked together with the VNP, the society of Dutch Paper and Board producing companies. I had gained some knowledge of the paper production process, its environmental, social and economic aspects, the culture of the sector, a few individual companies, and its stakeholders. I therefore had a good starting point from which to reach companies in the sector and understand their projects.

On 23 June 2005, I had a meeting with the Director of VNP, with the intention of asking for his assistance in the process of approaching directors of individual companies. In the course of our talk he confirmed his willingness to help me in my search for innovation cases and to introduce me to a number of companies. I sent him an abstract of my research plan, with a description of the help that I would require from the companies and interviewees. He used this to discuss my request with the company directors and advised me to contact certain companies. With this support, the selection of the sector was complete.

<u>The selection of the cases</u>

In selecting the innovation cases I took the following steps. I wanted to find evidence on a number of specific innovation processes in various contexts and with various aims in order to be able to compare them and draw conclusions for a variety of situations. I was especially interested in differences and similarities between innovation processes that were driven mainly by business motives and innovation processes that also took into account goals in the areas of environmental protection and/or sustainable development. My motivation for this division was that I wanted to discover the extent to which the characteristics of the innovation processes and the applied capabilities and methods were related to the development of changes in reaction to economic and environmental issues. I decided to try to find two examples of each kind of innovation process. These examples were revealed to me in the following way.

Through the association of Dutch paper and board producing companies (VNP)
The director of VNP and the director of the KCPK (the knowledge centre for the Dutch paper and board producing sector) suggested that I approach three companies that were regarded as being innovative. When I had approached the directors of these companies through letters of introduction and telephone conversations, one company displayed a willingness to cooperate in principle: Company A. The other ones had different reasons for not participating in the research. On February 8, 2006, I met the Director of company A for the first time. In that meeting, I agreed that the Rofire project would be part of the study, and I could immediately conduct the first interview. The Rofire case is an example of an innovation process motivated by business and environmental goals.

Through contacts made at a convention of the sector in 2006
On January 10 and 11, 2006, an international paper and board event was held at the Technical University in Delft, The Netherlands. One of the subjects of this convention was board in architecture, art and building technology. At this convention I met the manager of the technological department at Company C. After the convention I approached this manager (February 9, 2006) with a request to discuss the possibility that Company C might participate in the research. We met on February 22, 2006. I was introduced to the Director of Operations and in the meeting they agreed to cooperate on the research and to provide two examples of innovation cases: one case driven by business and environmental reasons (the Dry Low Nox Emissions gas turbine project) and one motivated mainly by business reasons (the Task Force Ruptures project).

By suggestion of the director of Company A
While the case study in Company A was running I asked the director if he could suggest to me a company that could provide me with a second innovation case. The director recommended that I approach Company B, also known as innovative company. I approached the director of Company B with a letter dated May 18, 2006. Shortly after that date I met with the Director and he also agreed to cooperate in the research. I would research the Wetlaid case, which is an example of an innovation process motivated by the need to increase competitiveness.

Differences between the selected companies
The three companies that cooperated in the research differ on several levels.

Ownership structure and financing
Company A is part of a multinational whose shares are traded at the International Stock Exchange in New York and the London Stock Exchange. Company B is a privately owned company, and Company C is an independent company whose shares are traded on the Amsterdam Stock Exchange. Company A is financed through the Group that it belongs to. Company B is financed privately, and Company C is financed through the emission of shares on the Amsterdam Stock Exchange.

Headquarter location
The headquarter location of Company A is in Ireland. The headquarters of the Companies A and B are in The Netherlands.

Degree of autonomy and government structure
Company A is subject to the policies of the group that it belongs to. The director of Company A is held to be responsible by the management of the Group. The director of Company B is also owner of the company and has the liberty to make decisions on policies and strategies. The director of Company C is held to be responsible by the Directors of the Supervisory Board and the general meeting of shareholders.

Markets served
Company A produces paper for the corrugated board industry. In addition, it produces approximately 15,000 tons per year of Rofire pellets from combustible components that are unsuitable for use in the paper production process. Company B produces paper that serves as a basis for washroom products (hand towels, wiping roils, toilet paper) and facial tissues, paper handkerchiefs, kitchen rolls, jet towels and hospital rolls from recycled paper. In a separate factory it also produces these products, and it also sells related products like soap and dispensers. Company C produces a range of graphic specialties for business purposes (envelopes, printing paper), promotion (brochures) and publishing (books, manuals and stationery).

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4.5 Concluding remarks

In this section, I explained the research philosophy. I see academic research as having an important role in increasing our in-depth understanding and knowledge of the world, and company practice as an important source of learning. I highlighted what I see as the limited generalization potential of empirical research; that the data is not the project; that cultural orientations determine meanings; and that innovation projects are developed in social construction processes. I explained the use of a combined deductive and inductive approach and my reasons for using case study research and the narrative interview method. Further, I explained how I selected the four cases and I provided an overview of the differences between the selected companies.

Chapter 4 forms the last introductory chapter before starting the collection, presentation and analysis of data in the chapters 5, 6, 7 and 8.

5 Introduction to the Dutch paper and board industry

5.1 Introduction

I have specified the general problem description in chapter 2. I have performed literature research on innovation, sustainable development, (inter-)organizational learning, dynamic capabilities and creativity, and I constructed the research questions in chapter 3. In chapter 4, I explained the applied research philosophy and method.

In this chapter, I introduce the Dutch paper and board producing sector and sketch the main themes that have influenced the development of the sector and that form the historical context of the projects that I have researched. This section is largely based on the study *Op papier gesteld. De geschiedenis van de Nederlandse papier en kartonindustrie in de twintigste eeuw* (Bouwens, 2004) (translation: *Put on paper. The history of the Dutch paper and board producing industry in the 20th century*), and on *Papierfabricage in Nederland in de negentiende eeuw. Van molen naar fabriek* (Wit, 1990) (translation: *Paper production in The Netherlands in the nineteenth century. From mill to factory*).

This chapter aims to draw a developmental picture of the sector to which the four projects and three companies that I researched belong. I first look at the history of the sector in 5.2. In section 5.3, I proceed to sketch an image of the production process and of sustainability issues in The Netherlands. In 5.4, I present concluding remarks that relate the themes of the sector to the selected cases. The cases and companies are presented in chapter 6.

5.2 Brief history of the Dutch paper and board industry

"Paper has been produced for some 2,000 years, but for most of that time, it was a specialty, artisanal product derived from the fibers of rags and various nonwoody plants including the one from which it gets its name—the giant reed, papyrus" (McGinn, 2000, 19). In the year 1428, the building of a water mill for paper production in Gennep marked the beginning of the Dutch paper and board producing sector. From that moment on, the production of papyrus and parchment in The Republic was slowly replaced by paper made from fibers that were derived from cotton or linen rags. In the new production process, assorted rags were first cut into strips by employees and then mechanically battered to fibers by wind- or water-powered hammers in large buckets of water. In a later

machine (invented in Holland and thus called the 'Hollander') the rags were cut using bronze knives and ground up using a rotating press. Thus the textile fibers became available, mixed with water. With the aid of a sieve, a craftsman would then scoop the fibers out of the water, shake the sieve to let the water flow out, place the sheet on a flat surface, press out any excess water, and hang the paper sheets out to dry. After drying, the surface of the paper was treated (e.g. with glue) to improve its quality and make it suitable for writing or printing purposes. After this treatment the paper had to be pressed dry again.

The Hollander increased the speed of production by up to three times the original speed, but it demanded more energy than most of the watermills could provide. Wind-powered mills were particularly suitable for the Hollander because of their greater power. Both for water- and wind-powered mills, several hundreds of liters of water were used per kilogram of paper produced.

The invention of the technique of printing, combined with the growth of Amsterdam as a trade centre, greatly stimulated the demand for paper, which led to an increase in the number of paper mills. But the demand for paper far exceeded the supply, and therefore paper had to be imported also from Germany, Switzerland and France. The quality of the work of Dutch paper makers was renowned far and wide, and their watermarks were imitated by foreign producers, who also tried to persuade Dutch craftsmen to come and work for them abroad.

The character of the paper mills in The Republic was closely connected to the specific local natural and social economic environment. In the west (a region called the Zaanstreek) paper mills were powered by wind, and in the east (the Veluwe) by water from partly artificial brooks. Wind and water were not free but had to be leased from the local lord or landowner. In the mills in the Zaanstreek, up to 25 people were employed per mill and ownership was spread over several stockholders. Wages were higher in the Zaanstreek than in the Veluwe. This was as compensation for the times when there was no wind and employees could not work. In the Veluwe, the mills mostly employed four to six people and were owned by families that for reasons of income security combined paper production with agriculture or animal husbandry. The paper maker was a respected person in local society, as he was often the only 'industrial' employer in the area and exercised a craft that required years of practice. In the Zaanstreek, there were 40 mills around the year 1720, whereas this number was 160 in the Veluwe.

Paper was an expensive product, and for centuries it was mainly used by the government, the nobility, the church and rich citizens. This situation changed in the nineteenth century. The paper producing sector suffered from international competition. Through the protectionist trade policies of several countries, the prices of raw materials (rags) increased and their availability decreased. For example, France levied duties on the import of paper, whereas the Dutch market was relatively open to exporters. In combination with the liberal trade policies of The Republic and the worsening economic situation of Amsterdam, protectionism began to put pressure on the profits of the paper mills. Technological innovations like the invention of the paper production machine in France (1798), the bleaching of fibers with chlorine (1777), and the gluing of paper with resins (1827) strengthened foreign competition. The paper production machine increased the production speed by up to more than five times the speed of a paper mil in the Zaanstreek (in 1846). Aided by tariff walls, producers outside The Netherlands quickly adopted the paper production machine and built an impressive mechanized paper production sector.

Under these circumstances, at the beginning of the nineteenth century, the Dutch paper mills were also forced to mechanize. They had to search for additional funds to invest in machines to increase the scale of their production and to transform their trade from a craft into an industry. This development caused the price of paper to fall. Around 1850, Dutch producers served only 3.5% of the European market in paper. Germany served 40%, England 21.3%, France 13% and Belgium 5%. The number of mills in The Netherlands decreased from 201 in 1819 to 137 in 1869 (see table 5.1).

Table 5.1 The number of paper mills and factories in The Netherlands in the nineteenth century (from Wit, 1990)

Province	1819	1839	1852	1869	1898
Friesland	1	1	1	2	?
Groningen	1	1	0	1	?
Overijssel	6	6	5	3	?
Gelderland	134	129	122	104	20
North Holland	33	24	16	12	3
South Holland	21	17	15	10	?
North Brabant	1	1	1	1	?
Limburg	4	4	3	4	?
Total	**201**	**183**	**163**	**137**	**35**

Cooperation between paper mills was initiated as a means of survival, and a search began for alternative raw materials to diminish the dependency on rags, a scarce resource now in the light of increasing paper production. This scarcity stimulated paper producers to bleach rags and use rags of inferior quality. This had a negative effect on the quality of the paper.

In the 19th century, board was produced from straw and peat, and paper was produced also from wood powder and cellulose. Paper made from wood powder was strong and absorbed ink very well, and the price of wood was lower than that of rags. A disadvantage was the presence in wood powder of substances like lignin, which caused paper to turn yellow under the influence of sunlight. Through the invention of a treatment with sulphite, however, this problem was solved. In 1885, the first cellulose factory in The Netherlands was built. Slowly, wood powder and cellulose replaced rags as the most commonly used resource for paper production. With this shift, Dutch producers quickly followed the developments abroad.

Increasing the scale of production and lowering production costs were necessary if the companies wished to be able to resist international competition. Steam engines helped to increase the production speeds, but the need for fuel also caused production costs to increase. Peat was not a satisfactory fuel for steam engines, and so coal was imported from England (except in the south of the province of Limburg where coal could be mined nearby). However, the labor costs per product were lower than for handmade paper.

After the delayed adoption of mechanization, the first teething troubles were eventually overcome and Dutch companies were able to compete again in the international markets. (Table 5.2 gives an impression of the mechanization of the sector in the nineteenth century). The value of exports increased. In 1904, the owners of sixteen paper mills gathered to collectively manage their interests and the Association of Dutch Paper Producers (VNP) was born. But the market share for handcrafted paper fell and, at the end of the nineteenth century, paper mills in the Veluwe had given up producing paper and had switched to bleaching and washing textiles.

Table 5.2 The mechanization of the Dutch paper producing sector (from Wit, 1990)

	1847	**1852**	**1869**	**1898**
Number of mechanized factories	5	6	12	35
Number of paper production machines	6	9	20	?

As a result of these developments, in the first 40 years of the 20th century the number of companies, the number of people employed, and the production increased. However, the industry had become a capital-intensive sector that was dependent on imported resources, and this situation was a threat to the continuity of the companies. It stimulated further cooperation in the VNP to defend common interests, e.g. through the creation of various kinds of cartel agreements.

After the Second World War, the sector profited from low energy prices, the moderate level of wages, and the increased demand for paper and board. Companies searched for the financial means to expand and they achieved productivity improvements and production growth. The expansion of the sector in the 1950s and 1960s (through increased scale of production, revenues and production capacity) was also made possible by the increased capacity in Scandinavia to produce cellulose, and the expanded production of cellulose and wood powder in Canada and the United States. Despite these developments, the paper and board producing sector remained focused on decreasing its level of dependency on imported resources. The collection and recycling of used paper was seen as a way of achieving this goal, also because the price of used paper was only a third of the price of imported resources.

As a result of its growth, the sector gradually developed an overcapacity and international competition increased due to the increased scale of production and the vertical integration of North European pulp producers. The price of imported cellulose and wood powder increased faster than the price of Dutch end products. This development stimulated Dutch companies to merge.

In the 1970s, inflation, a stagnating world trade and low economic confidence caused an economic downturn. In The Netherlands, the costs of production increased through the rising cost of labor, capital, energy and resources. Higher energy prices, in particular, negatively impacted on profit margins. In addition to this, environmental regulation forced paper and board producing companies to limit emissions into the environment. New laws concerning the pollution of surface water stimulated companies to find ways of decreasing the amount of wastewater. These developments led to a change in the investment patterns of companies and to increased coordination by the VNP in environmental matters and in efforts to diminish dependency on imported resources. Investment was now directed at the improvement of production processes and the modernization of the means of production. Many Dutch paper and board producing companies merged or intensified their cooperation.

In 1982, the economic crisis peaked, and shortly afterwards prospects improved. As a result of restructuring efforts, at the beginning of the 1980s the sector had realized improved labor productivity, modern machinery, a reduced use of energy, lower levels of water use and water pollution, and a more advantageous resource position. Production costs had been lowered and the paper and board producing sector achieved improved profits. Investment grew again and company strategies were directed at specialization and the increase of the scale of production. The sector became part of a global industry and international markets. The success of the sector was supported by the decreased use of imported resources and better control of energy and environmental costs. Overcapacity and international competition stimulated companies to integrate forward and backward.

In order to control the risks of increased scale of production and to manage costs, internationally operating companies sought refuge in specialization, in a focus on core activities, in vertical integration and in horizontal concentration in different geographical regions. These processes were stimulated by the creation of an integrated European market. The result of these developments was that the Dutch paper and board producing sector increasingly became a part of multinational companies. In the years from 1989 to 1993, the amount of paper and board sold increased, but turnover decreased. The average price decreased, but in 1994 it increased again. The bad results in 1993 stimulated companies to reduce their costs and to restructure and rationalize their production. The number of production locations and employees decreased from 38 in 1980 to 30 in 1994 (see table 5.3) (Ministerie van Volkshuisvesting, Ruimtelijke Ordening en Milieubeheer, 1996).

Table 5.3 Production data of the paper and board producing sector (Ministerie van Volkshuisvesting, Ruimtelijke Ordening en Milieubeheer, 1996)

Paper and board production in1992	**Number of production locations per category**	**% of total production**
< 10 Kton	3	0.3
10 - 25 kton	5	3.7
25 - 50 kton	7	9.2
50 - 100 kton	9	24.3
100 - 250 kton	5	26.5
> 250 kton	3	36.0
Total	32	100.0

Dutch companies were attractive because of their modern machinery, the high level of education of their employees, the proximity of markets, and accomplishments in the fields of environment and energy. In 2003, only four independent Dutch paper producing companies were left. In this situation, the role of the VNP had changed. It became the organization that coordinated negotiations on behalf of the sector with the Dutch government with regard to memorandums of understanding on social and environmental issues. Corporate social responsibility became one of the spearheads of the VNP, and the organization balanced its activities between promoting environmental policies and strengthening competitive positions.

However, due to high prices of land and costly permit procedures, no further investment in new machines took place in The Netherlands. Several machines were taken out of production and, in 2002, the number of operating machines was down to 53. Production processes were optimized further and the speed of machines increased. Due to governmental regulation, the sector was forced to invest further in energy-saving measures and in measures aimed at reducing environmental effects.

In the first years of the 21st century, the paper and board producing sector began to grow explosively in South-East Asia. This trend originated in the large supply of raw materials, low wages and loose legislation. Used paper was exported to South-East Asia, with imports coming from Belgium and Germany. In The Netherlands in 2002, 77% of the volume of resources for paper production consisted of used paper.

5.3 The production process. Sustainable development issues.

In the modern paper production process, fibers, additives and water are the most common elements used. The Dutch paper and board producing sector mostly uses fibers from used paper, from trees and from the cotton plant. The additives vary and they influence the characteristics of the paper: its weight, thickness and strength, the qualities of its surface and the optical characteristics. In table 5.4, I list the different additives that were being used in The Netherlands in 1992, along with their applications (Regoort, 1992)

In order to create usable fibers from wood, these fibers have to be unlocked. First the bark is removed from the trees, and then the remaining wood is chipped and treated mechanically (with grinding stones and water), chemically, or with a combination of both, to destroy the lignin and free the separate fibers. The result of these processes is called the pulp or cellulose. When the fibers have been unlocked, the pulp is washed and then bleached to give the fibers the whiteness that is required. *“The standard bleach has been chlorine, and that has made the pulp and paper sector a major source of POPs*

and POP-like compounds. (…) In some regions, (…) 90 percent of organochlorines detected in the waters of the Baltic Sea and North American Great Lakes have been traced to pulp mill effluents" (McGinn, 2000, 19).
"At least 40 percent of the world's pulp supply is bleached with chlorine compounds, and until the mid 1990s, the standard method was to use pure, "elemental" chlorine, which produces the largest quantities of toxics. Industrial scale pulp mills are usually enormous facilities. Such a mill may produce 600 to 1,000 tons of pulp per day; if it is bleaching that pulp with elemental chlorine, it will also produce an average of 35 tons of chlorinated by-products per day. (…) But it's not just the volume of the emissions and the number of compounds that is troubling—it's also the tendency of these emissions to set off chemical reactions that produce more pernicious compounds" (McGinn, 2000, 21).

Table 5.4 The additives used in the Dutch paper and board producing sector (from Regoort, 1992)

Additive	**Goal**
Filling materials	To improve the printing characteristics and the whiteness, smoothness and toughness of the paper. To make the paper thin and smooth To improve the qualities of the color of the paper.
Glues	To improve the qualities of the surface of the paper
Binding agents	To improve the coating To improve the adhesiveness of coatings To improve the qualities of the surface of the paper
De-inking chemicals	To destroy the links between ink and paper fibers To bleach
Retention agents	To improve the retention of fibers and additives
Sticking agents	To improve the adhesion between additives and fibers
Coloring agents	To improve color and brightness
Anti-foaming agents	To prevent and dam foaming
Agents that fight slime	To oppose slime-forming bacteria
Cleaning agents	To clean the felt presses and sieves in the paper producing machine

In the next step, the pulp, additives, used paper and water are mixed in a way that produces a paper stock - a mixture that is 99.5% water and 0.5% fiber. Through several operations, the stock is then cleansed and de-inked again, fractioned, diluted, dispersed and ground to remove lumps. The fibers are roughened to increase their capacity to link with each other. Next, the paper stock enters the 'wet end' of the paper-making machine. It is sprayed onto moving mesh screens, which allow much of the water to drain off. This water contains fibers and it is returned to the beginning of the process and added to the stock again. More water is removed with felt mats and through heating by steam. Finally, when all the water has been removed and a dry paper sheet remains, the paper is wound onto spindles and processed further (e.g. with coatings) to give it its specific characteristics.

Environmental management, legislation and the role of public pressure

At the international level, the United Nations Environmental Programme in 1996 saw environmental management as the best way to work with environmental issues. It wrote (United Nations Environmental Programme, 1996): *"Environmental legislation, pollution taxes, fines and an increasing awareness among consumers have placed environmental issues high on the agenda of the pulp and paper industry. (…) For many companies environmental control or management has in fact become an issue of competitiveness and survival. In response to this trend a number of tools for use within an organization wishing to improve the environmental performance of its industrial plants have been developed and are being implemented by many different organizations world-wide. (…) The term environmental management stands for an integrated evaluation of the environmental impacts of pulp and paper making, covering all steps from fiber raw material sourcing to the environmental aspects of the product. It also stands for the implementation of efficient control measures with regard to cost, environmental effect and resource use, highlighting modified processes and equipment to prevent pollution generation and save resources."*. And regarding the role of legislation: *"Compliance with environmental legislation is a primary concern for most companies (…). This requires a company to make a commitment to take action to improve its environmental performance every time new or more stringent regulations are introduced by the authorities. This level of performance (…) is defined as 'reactive environmental management'. At the other end of the scale (…) performance can be termed 'fully pro-active environmental management"* (p.173-174).

However, as McGinn(2000) writes: *"There are thousands of small mills using obsolete technologies in China, Brazil, India, and other developing countries. Such mills may not treat their effluent at all—they often simply release it directly into the local waters"* (p.23). McGinn also finds that: *"In response to mounting public and legal pressure to clean up its organochlorine pollution, much of the industry is switching from elemental chlorine to a process that uses*

chlorine derivatives such as chlorine dioxide (ClO_2). This (…) can radically cut total organochlorine emissions. (…) But ECF is a kind of "low tar cigarette" approach to the problem of organochlorine pollution. It reduces pollution, but does not address the fundamental problem—the industry's addiction to a substance that it would be better off avoiding in the first place. There is no need to use chlorine at all in the bleaching process" (Mcginn, 2000, p.25-26).
Hafner and Hafner (2008) have concluded the following on the role of public pressure in their studies of innovation and the diffusion of bleaching technologies in the pulp industry: *"(…)Detection of trace amounts of dioxin in products such as diapers and coffee filters led to increased awareness of the issue, particularly in Europe. In response, the development of alternative bleaching technologies increased rapidly in each of the countries examined. Moreover, this increase occurred before new environmental regulations could be put in place limiting chlorine use, suggesting that public pressure, rather than regulation, was the primary driver of this first wave of innovation*" (p.131-132).

The United Nations Environmental Programme (1996, 175) listed as the key components of an Environmental Management System an environmental policy, an assessment and evaluation of environmental impacts, a register of environmental effects, objectives and targets, an environmental management program, an environmental management manual and documentation, organization, communication and personnel, operational controls, and monitoring and re-evaluation to support continual improvement. Regarding objectives and targets of environmental management, the UNEP stated the following (United Nations Environmental Programme, 1996): *"For most pulp and paper companies the first goal will be to comply with environmental legislation. In many cases it may also be very important to protect and develop a sustained, local fiber raw material source and for to protect the quality of a local river to safeguard its further use for irrigation or other downstream purposes. Increased environmental awareness among stakeholders may often encourage companies to set goals that go further than formal requirements"* (p. 178). However, I found that innovation and cooperation with actors from outside the company in innovative projects to reduce environmental pressures was, in 1996, not mentioned in UNEP's advice to the sector.

The adoption of energy efficiency improvements. Carbon dioxide emissions
The sector has focused on increasing energy efficiency, mostly for economic reasons. Chappin (2008) concludes that the effect of governmental environmental policies on the adoption of combined heat and power (CHP) installations in the years 1959 - 1995 may not always have been positive and

decisive. *"(…) In the case of the adoption of CHP-installations, the most important reason appeared to be the high energy price combined with the cost price reduction or the threat of regulation. With regard to policy instruments, interactive regulations have had the largest impact on CHP adoption, while positive economic instruments have been important as a stimulus"* (p.135). *"We can conclude that the relative role of the industry is largest in the policy-making process of interactive regulation. 'This interactive regulation also seems to have the largest effects on the adoption processes of CHP-installations. These findings suggest support for the argument that the involvement of stakeholders in policy-making processes results in more effective regulation' (Rennings, 2000). However, one should not forget that firms also have other reasons (such as cost price reduction) for innovating. (…) We further found that, while the accumulation of policy instruments can result in positive effects (reinforcement of instruments), it can also result in negative situations in which firms become risk-avoiding or discouraged. Policy makers should be aware that different instruments are based on different behavioural mechanisms. Having insight into the industry, its behaviour, production processes, hot topics, problems, etc. before policies are implemented can result in a better alignment of aims of both government and industry. The involvement of the industry is a relatively easy way of achieving this, which again hints at interactive regulation"* (p. 135-136).

Regarding the learning process that companies have gone through in the adoption process of CHP installations from 1959 to 1995, Chappin found that technological complexity has stimulated companies to attract knowledge from external partners, but that the government did not play a direct role in this. In 1989, the energy consumption in the paper and board industries was 1.4% of the total energy consumption in The Netherlands (Cuelenaere et al., 1992). In the period 1970 – 1989, this consumption level fluctuated between 27 and 37PJ. In that period, the physical production of the sector increased from nearly 1600 million kg to nearly 2600 million. On average, in the period 1978 – 1989, the annual changes in energy intensities (based on primary energy requirement) were -4.3% based on the value added, -2.9% based on financial output, and -3.0% based on physical production. The carbon dioxide intensity exhibited the same decrease as the energy intensities.

Waste streams

In 1995, the Dutch paper and board producing sector could be divided into three types of companies, from the perspective of waste streams. Fifteen companies (approximately 50% of production) processed used paper and had no de-inking process. Seven companies (approx. 24% of production) processed used paper and de-inked the inputs. Nine companies (approx. 27% of production) use virgin fiber as inputs. These companies produce the waste streams that are presented in table 5.5.

Table 5.5. Main waste streams of the paper and board producing sector (Ministerie van Volkshuisvesting, Ruimtelijke Ordening en Milieubeheer, 1996)

Waste category	Total quantity in 1993 (in kton)	Quantity reused (in kton)
rejects	130.0	-
paper sludge	37.8	11.7
de-inking sludge	215,0	47.0
sewage sludge	77.5	41.0
paper/board	4.6	3,5
bark and wood residues	21.4	21.0
packaging waste	23 (1994)	46% reuse, 50% landfill, 4% incineration

The ministry of the environment drew up an inventory of measures that could prevent waste, and found the following. Rejects could be prevented by optimizing the use of fibers in the pulping process. After they had come into existence, rejects could be processed better by drying or gassing them. Paper sludge and de-inking sludge could be prevented by optimizing the use of fibers in the paper production process and the pulping process respectively, and sewage sludge could be prevented by a combination of aerobe and anaerobe cleaning (Ministerie van Volkshuisvesting, Ruimtelijke Ordening en Milieubeheer, 1996).

Waste water

Regoort (1992) finds that the Dutch law to prevent and limit the pollution of surface water (WVO, Wet Verontreining Oppervlaktewater), which came into force in December 1970, has helped greatly to decrease the emissions of diverse substances into surface waters.

The production of cellulose through chemical treatments has been stopped in The Netherlands, and emissions have also been decreased through source measures, adaptations in the production processes and further cleaning of waste water. Bleaching is no longer done using chlorine containing agents. *"Chemical pulp is not produced in the Netherlands (…). There is no tradition of bleaching with chlorine in The Netherlands, and also no pulp production. All companies that use white fibers import them from abroad. More than 80% of our* *resources consist of used paper, and most of the companies use it after mechanical cleaning. A part of the used paper is de-inked, and a small part is bleached a little. Relatively mild bleaching agents are used for this, especially hydrogen peroxide and enzymes. In this kind of processes chlorine has never been used in The Netherlands"* (Hooimeijer, 2012).

Through the reuse of water, the amount of water used in production has been reduced from 50 - 600 cubic meters of water per ton of paper to 15 - 20 cubic meters. But despite the measures that have been taken, in 1992 substances listed under pesticides, chlorophenols, PCB's, aromatics, volatile chlorinated hydrocarbons, heavy metals, nitrogen and phosphates were still being emitted. However, Regoort (1992) suggested that due to preventive measures a further decrease of the emissions may be expected, and that it is not necessary to prescribe additional measures to clean waste water.

Research carried out at a paper producing factory in 1994 into finding ways to prevent the dumping of sewage sludge showed that diverse possibilities exist for re-use of the sludge by users outside the factory (e.g. the cement industry, stone industry, the production of building materials), but that the environmental consequences of these had not been sufficiently charted. The prevention of sewage sludge was financially unattractive in the factory that was researched, and the provincial waste policies steered the choice of the company in the direction of burning the sewage sludge.

Continued efforts to decrease raw materials dependency, energy costs and environmental pressure.

Raw materials took up the largest portion of cost prices, and therefore the sector (through the VNP) aimed to protect the supply and to increase the relative use of used paper. This was agreed in cooperation with the Ministry of Economic Affairs, who participated for economic, strategic, environmental and social reasons. Projects were initiated to protect the collection systems for used paper, and to store, clean and de-ink used paper. Companies tried to improve their grip on the supply of used paper by integrating backwards. As a result of these efforts, in 1993 used paper formed nearly 75% of the produced paper and 99% of the produced board. Only graphic paper remained dependent on cellulose and wood powder. This development is in line with what Leufkens and Noorderhaven state regarding interests and project-related behavior: *"In many sectors technological and other developments destabilize given role sets of incumbent organizations. As a consequence, these players may come to question their existing strategy and redefine the 'architecture' of the industry"* (p.434).

The sector also tried to improve the national supply of wood for the production of paper, but this was not a success due to difficulties with regional planning policies. Long-term contracts were agreed with suppliers of raw materials in Scandinavia, Canada, the United States of America and Finland.

In 1990, the VNP started to develop an environmental management system, resulting in an environmental handbook. In 1994, three quarters of the sector had implemented these environmental management systems. A number of different companies were implementing environmental management according to BS7750 (Ministerie van Volkshuisvesting, Ruimtelijke Ordening en Milieubeheer, 1996). The sector also strived to get all companies to design a company environmental plan (BMP). In 1995, the sector supported the governmental goal to close the paper and board cycle, even in times where prices do not cover all the costs.

The sector had also agreed with the Ministry of Economic affairs to reduce the energy use by 14% in the period from 1989 to 1995, and to reach a 20% reduction in 2000 compared with 1989. With support from the Dutch Government, paper and board producing companies managed to reduce the costs of energy through investing in energy saving measures and combined heat and power installations.

In 1994, Wolters et al (1994) expected that societal requirements regarding sustainable production would be more stringent in the first 20 years of the 21st century. These demands can only be realized, they suggested, if the costs of environmental measures can be completely included in the cost prices and if integrated chain management delivers further environmental improvements. Wolters et al expected that the strict process control that is needed to generate environmental improvements is possible, given the advantages in costs and competitive position that technological improvements offer. In their opinion, the use of non-renewable energy sources and unsustainable forestry practices posed the only major sustainability problems for the sector in the longer run.

Searching for possibilities to strengthen the Dutch paper and board producing sector, Wolters et al (1994) also advised that innovation policies concentrate on the development of technologies that drastically reduce the use of resources and the emission of substances, on the acceleration of processes of innovation and diffusion, and on promoting innovations that are useful in the long run and that satisfy multiple goals. Regarding the availability of wood, they conclude that although there is much pressure on forested areas, this does not seem to threaten the availability of wood, because of the use of plantations and production forests. But in order to prevent future problems, sustainable forestry should be realized. The sector could also look for alternative sources of cellulose, like different kinds of plants and waste wood from other industries.

Led by the VNP, the sector is striving to reduce its energy use by 50% in 2020 through an “energy transition” program. Best practices are being exchanged among companies and the sector is cooperating with academic institutions.

5.4 Concluding remarks

In this chapter, the paper and board producing sector was introduced, with the aim of arriving at a better understanding of the context of the researched projects and companies.

Overviewing the history of the Dutch paper and board producing sector, Bouwens (2004) concludes that in the second half of the 20th century the sector succeeded in diminishing its age-old dependency on scarce resources and in counteracting the rising costs of energy, labor and environmental regulations. Companies have been forced again and again to adapt to international competition, the power of the suppliers of raw materials, fluctuating demand, and the requirements of national and international governments. In these adaptation processes, companies have created strategies that include increased scales of production, concentration, specialization and internationalization, leading, in The Netherlands, to a lower number of companies that each produce more tons of paper and board, and that collaborate via the VNP organization.

Interpreting the information in 5.2 and 5.3 as the context for the innovation efforts of the sector, I conclude that the main and constant themes were resource scarcity and dependency, energy intensity of the production process and rising energy prices, various environmental issues, productivity and international competition. These themes directly influence the costs, prices and profit margins of the sector, and have therefore always been drivers of efforts to innovate and collaborate.

The cases that I have selected and that are presented in chapter 6 are all related to these themes: innovation in the Rofire case addresses environmental and cost issues; in the Wetlaid case, innovation addresses the issue of international competition; the Task Force Ruptures project deals with productivity and product development issues; and the DLE project is a reaction to environmental and cost issues. New forms of collaboration have been started in all projects.

In chapter 6, I explain how I understand these innovation processes and in chapter 7, I present the analysis of the cases. In chapter 8, I explain the cross-case analyses, culminating in a conceptual model of the dynamics of inter-organizational learning for innovation (chapter 9) and theoretical propositions and recommendations (chapter 10).

6 Company introductions and case descriptions

6.1 Introduction

Having just described the development of the Dutch paper and board producing sector in chapter 5, in this chapter the three companies and four cases are introduced. I present only the main characteristics for each company (sections 6.2 to 6.5), as they wish to remain anonymous. Each project, however, is presented with details in a format that allows insight into the different issues, the innovation activities, the related organizational structures, the actors that were involved and, finally, the outcomes and further developments. In chapter 7, the projects are analyzed, and in chapter 8 cross-case analyses are presented. These chapters create the main input for the answers to the research questions, the conclusions and the recommendations in chapters 9 and 10.

6.2 Company A: the Rofire project

Company introduction

Company A is a medium-sized company that is part of a multinational. It produces paper from recycled paper and board as a basis for packaging board. It processes 600.000 tons of waste paper and produces 550.000 tons of new paper on an annual basis.

In the 1970s, the predecessor of the company was forced to downsize considerably and only one hundred employees were able to keep their job at the factory. As a result, employees and management are reported to be very aware of the need to work carefully and to continuously improve efficiency, in order to be able to compete with low wage countries and to protect manufacturing industry and employment in The Netherlands. Drawing on the lessons from its past, the company has developed a culture of continuous improvement.

The company works with a system of five shifts. In combination with the need to run a continuous production process, this means that deliberate efforts have to be made by the employees to share information on the status of the production process and improvement projects. This is why the company strives for openness, informal information sharing on the work floor and regular work meetings.

The General Director at the time of the interviews had been the company's Technical Director in the past. He recognizes the importance of teamwork and of communicating to employees the value of their contribution. Employees are reported to be loyal to the company, and the company invests in their education and training. The company improves efficiency by focusing on small improvements and keeping a keen eye on the costs and the risks, thus staying ahead of the competition. In this way, the production of a certain paper production machine was increased from 350,000 tons to 500,000 tons per year. The production speed is 950 meters per minute, whereas some competitors reach a speed of only 360 meters per minute.

Innovation is seen by the Director as "making new combinations of old and known elements". He regards innovation as a nuisance in a production environment, because it brings the risk of failure and may endanger the company. Therefore, risk management is a crucial part of innovation in a production environment.

The company also strives to reduce environmental impacts. Noise levels have been brought down, and the recovery of energy from warm air from the drying installations is achieved using scrubbers. The company has also developed the Rofire product - a fuel pellet made out of the rejects from the paper production process.

Case description

In the Rofire project, Company A searched for and found a way to turn a waste stream that originated from the recycling of used paper into marketable fuel pellets. Together with specialists from DSM and other subcontractors, the company developed a new production process, a new product and a new market.

Problem description – company and societal issues

In the second half of the 1990s in the Province of Limburg, The Netherlands, representatives of the Provincial government, the paper and board producing industry, the waste processing industry, electricity production and plastic producing companies, met several times a year under the name of Subcoal. The group was a reaction to the national government policy on reducing waste streams, the dumping of waste, the burning of energy-rich waste, and the use of fossil fuels. The aim of Subcoal was to promote the development of fuel from the paper and plastic that could be separated from household and industrial waste. The idea was to use this fuel to replace coal in electricity plants and fossil fuels in other industrial burning processes.

In the same period, the Technical Director of Company A was reflecting on alternatives for dumping or burning paper recycling waste. He did this for two reasons. First, competition in the paper and board producing industry is severe and companies are continuously forced to innovate and improve efficiency. Company A uses used paper as an input in the production process. The paper is turned into pulp with water, and then the non-paper materials are filtered out. Approximately five or six percent of used paper consists of wood, several kinds of valuable metals, and textile and plastics (including PVC). This fraction of five or six percent is called rejects. Part of it is valuable in itself, e.g. the 40 tons of aluminum filtered out yearly. Adding value to the rest of this stream of rejects, that would otherwise be dumped in a landfill or burned as waste, could be a way to improve the efficiency of the company. Furthermore, Dutch national waste policy was focused at the time on reducing dumping practices by gradually increasing dumping fees. Also, the burning of waste is priced, and finding alternative uses for rejects was becoming increasingly economically attractive.

The ambitions of Subcoal and Company A were seen to be complementary, and talks were started to see if the stream of rejects from Company A could be transformed into fuel. These informal talks marked the beginning of the Rofire project.

Innovation processes

The talks between Subcoal and Company A can be seen as the start of a number of innovation processes.

I have identified activities in which the company and societal issues were defined, and in which initial ideas and concepts were developed. These activities were performed in the Subcoal meetings, in the reflections of the Technical Director on waste, and in the teams that worked on the development of a new production process and on product and market development.

In his reflections, the Technical Director of Company A concluded that what is regarded as waste depends on the context. He began to see the factory not just as a producer of board but also as a used paper recycling factory. From that point of view, not only the paper fibers but also the rejects became potential resources for new products. This change of perspective is the innovative part of the project.

Using an instrument called Lansink's Ladder, the Technical Director found that the best option for the rejects would be to turn them into a secondary product of board production, namely a fuel for industrial burning processes. DSM, one of the participants in Subcoal, owned a patent on the production of fuel pellets from mixed paper and plastic waste streams. Company A decided to hire the DSM representative as a consultant for the development of fuel pellets.

Following the development of new ideas and concepts, there were activities in which the new fuel pellet and its production process were developed. New knowledge and equipment were collected and tested. Also, market research and development were carried out by Company A and DSM in order to compose a picture of customer requirements, to find a first customer, and to tailor the product and production processes.

The outcome of these activities was the design of a production process that consisted of the following steps. First, metals would be extracted from the wet stream of rejects. Then the remaining material would be shredded, dried and pressed into pellets of a specific size. The research made clear that due to their plastic content, the pellets would have a caloric value high enough to categorize them as fuel, but also that the PVC content from packaging material and tape could cause chloride formation in the burning process.

In the cooperation between Company A and DSM, product development was carried out in close consultation with production process development and market research. This integrated approach was made possible by DSM. Their contribution consisted of specialized knowledge on and experience with waste streams, knowledge on pelletizing paper-plastic mixtures, access to DSM research facilities, and access to networks in diverse industries with potential customers or suppliers.

The teams at DSM and Company A sounded out electricity plants, a cement kiln (ENCI, Maastricht) and a blast-furnace company as potential customers. The team learned the requirements of these companies and found that the chloride content of the pellets was not allowed to rise above a certain limit. The electricity plants and blast-furnace company were not interested in using the fuel pellets, as they were afraid the chloride would pollute their installations and lead to high cleaning costs.

The research showed that producing the pellets was not difficult. The problem was finding the right customer for this particular reject material; one that contained chloride and that was associated with waste and problematic emissions when burned. However, the cement factory ENCI was interested.

Because of the rising costs of fossil fuels, ENCI had already recognized as far back as in the 1970s the need to replace fossil fuels with alternative, secondary fuels. These secondary fuels are often former waste streams that carry a negative economic value. Usually, these fuels require extra environmental measures or special handling. Therefore, parties that supply secondary fuels usually pay ENCI to burn them. The ENCI kiln in Maastricht uses different kinds of secondary fuels to cover 85% of its energy needs. The exact combination of fuels depended on market prices, availability, environmental effects, caloric value and effects in the burning process.

The Technical Director of company A stressed during the research the importance of testing and of only using proven technologies, in order to reduce the risks involved in production. He considered the risk of marketing a new product to be so great that he wanted to avoid unnecessary risks in the production process. In order to orient itself, the Company A/DSM team visited pellet-producing facilities in a waste processing company in Amsterdam, and searched for suppliers of drying, shredding and pelletizing equipment that would meet the demands of the envisaged production process. The Technical Director interviewed the director of another company in Germany to gain crucial knowledge on the pelletizing process.

Before ordering the equipment, tests were done to see if the planned production process would work using with the rejects of Company A, and to learn more about optimal pellet sizes. For these tests, equipment was used that was already installed at other companies in Germany and The Netherlands. The material was transported between these companies to simulate the production process.

Then, when an amount of approximately 1100 tons pellets had been produced, a pilot was done at the facilities of ENCI to observe the effects of the pellets on the cement kiln and the production process. The outcome was positive and, in 1999, ENCI signed a contract with Company A for the delivery of Rofire fuel pellets for a period of five years, starting one year later in the first quarter of the year 2000. This was a tight schedule for acquiring permits and building the facilities, but because the team was fairly small and because the Province had agreed to participate and opinions did not diverge very much any more, the whole process went quite quickly. Company A bought the equipment that had been tested, and building commenced on the production facilities. Company A and DSM worked together on the building and production processes. They coordinated subcontractors and suppliers, and managed to complete the project on time.

When production of the Rofire pellets started up, all of the main equipment (the shredder, the crane, the oven, the pelletizers) functioned as planned, except for the conveyor belts. These had not been tested, and it turned out that they oxidized quickly under the influence of water that remained in the material even after drying. The installation required a lot of maintenance and additional equipment was installed to sift pieces of copper out of the stream of rejects. There was a setback when the government lowered the maximum acceptable value for chloride in the Rofire pellets from 500 to 50mg. By drying the rejects at a lower temperature, however, a value of 40 mg could be reached.

In the year 2000, the project was ready to go and Company A began the production and delivery of Rofire. In principle, the investment would be earned back within four or five years.

Organizational structures

From the moment the contract between Company A and DSM was signed, the Rofire project was supported by several organizational arrangements.

DSM had a major influence on the research and development for the product, the production process and the market. The consultancy contract with DSM formed the structure upon which these activities were built. A general Steering Committee was composed from external parties to oversee the general direction of the project. The Provincial Deputy of Environmental Affairs participated in this committee. The organizational group structures at Company A were used to discuss the financial aspects of the project and to seek approval for a financing arrangement.

A delivery contract between Company A and cement factory ENCI was used as a basis to focus further research and development activities, and to customize the product to the needs of ENCI. An informal team managed the acquisition of the necessary permits from the Provincial Government. A formal meeting with 40 neighboring residents was held to inform people in the neighborhood and to prevent delays in the permit granting process.

Following the contract with DSM, a Project Steering Committee was formed to manage process and product development and the building of the production facility. Detailed product and process development were executed mainly by the Head Engineer of Company A and two DSM engineers.

As soon as the delivery contract was signed with ENCI, a Project Building Team was installed to start building the production facility. This team planned the building of the facility and managed relationships with other subcontractors and with suppliers of equipment. When all the choices had been made and plans had been completed, the Project Building Team was dissolved and replaced by three implementation groups: one to construct the building, one to manage the installation of the mechanical parts, and one to install electrical parts and control systems.

The managers I interviewed contributed by networking and by involving new actors in the organizational arrangements supporting the Rofire project. They contacted actors in their network (e.g. suppliers, customers, colleagues in research), initiated new contacts (e.g. with suppliers of specialized equipment, financing or research institutions), and involved actors who would be effected by or were related to the project (like the local and Provincial government, neighbors of Company A, technicians in the production department of Company A).

Furthermore, managers contributed by forming teams and arranging or presiding over meetings. This was done mainly by the Technical Director, the Head Engineer of Company A, and the DSM Recycling Manager. The managers invited people to the teams that make up the multi-actor innovation structures and decided on the composition of these teams. Different teams were formed during the project, and the composition of the teams changed when the project moved forward. The teams and groups were the platforms upon which the participating actors performed the innovation processes.

Actors

Several different organizations and specialists contributed to and cooperated in the Rofire project. The main actors are described below.

The Technical Director and Financial Director had drawn up a business case for building the Rofire installation and producing the pellets. The project would demand an investment of approximately HFL 6 million Dutch guilders. Company A was part of a group of companies that recycled paper, and the General Director of Company A was also the director of this group. He presented the investment proposal to the Division Director, who granted approval, on the condition that it would not affect the profit and loss account of Company A. Therefore, Siemens was approached with the request to invest in the project and lease it to Company A. Siemens agreed, on the condition that they would be the license holder for future projects. The Head Engineer of Company A also participated in the project.

Company A is located within the city limits, and in order to have the permission granting process run smoothly, it was important to correctly inform the neighboring residents in the area. The company invited its neighbors to a meeting where the plans for the Rofire installation were presented and explained. Approximately 40 (out of 50 – 60) residents attended the meeting. Environmental organizations were not invited because the Technical Director feared they would delay the permit acquisition. In the meeting, it was explained how the reject material would be treated and that no hazardous emissions would occur. Additionally, an informative website on Rofire was constructed and a truck was painted with the Rofire logo.

DSM was hired to guide the research and product, process and market development process, together with Company A. A number of subcontractors were hired to build the facilities.

At ENCI, a Project team was put to work testing and supervising the introduction of the Rofire pellets. This team consisted of the production manager, his assistant and operators, an engineer, a trouble-shooter, a purchaser, a researcher and someone specialized in authorizations. The composition of the team was a logical consequence of the fact that research needed to be done. The ENCI project team also involved external research institutions, e.g. TNO and the Flame Institute.

The Provincial Authorities were involved in the project via the Subcoal group. In principle, the authorities supported the initiative because it reduced the dumping of waste. ENCI and Company A operated as a team when dealing with the Provincial Authorities and maintained direct contact with the Deputy of Environmental Affairs. He supported new initiatives like the Rofire project and led the discussions with the Provincial Permissions Department. These discussions focused on the transfer of the reject material (that the authorities were used to regarding as waste) in the form of pellets from the Company A to the ENCI site. Also important were the environmental effects of the burning of Rofire at ENCI. These effects had to be researched and reports had to be delivered to the authorities. Finally, the necessary permits were granted in time.

Outcomes and further developments

One innovative outcome of the Rofire project was the discovery of the pelletizing method for a substance that consists largely of plastics. DSM has acquired the intellectual property for this invention, thanks to the service agreement with Company A.

INTERVIEWEE: “The terms and conditions state very clearly that the invention is the property of DSM.”
QUESTION [HvK]: “What was meant here by the word ‘invention’? What was the discussion actually about?”
INTERVIEWEE: “In the first instance ….. making pellets was not something new, but a fuel containing more plastic was…. Drying is also not new….. It had mostly to do with how you actually made the pellets, their hardness, which matrix type etc. It was concentrated mostly on the pelletizer. Industrial ovens and power stations are also mentioned” (The Engineer environmental research of DSM).

In the first quarter of the year 2000, ENCI started to add Rofire as a secondary fuel to their production process. Shortly afterwards, the Dutch Government started to pay companies for burning fat waste and meal. The chloride content in the Rofire pellets proved to be higher than expected, and this diminished the capacity of ENCI to use other secondary fuels next to Rofire. ENCI discussed these developments with Company A, and ENCI decided to stop buying Rofire once the five-year contract had expired.

Looking back, interviewees report that mistakes seem to have been made in the measurement of the chloride content of Rofire. In actual fact, the chloride content turned out to be twice as high as in the tests. The marketing of Rofire in The Netherlands and abroad was difficult. Secondary fuels derived from former waste streams had a negative image in The Netherlands, mainly due to a scandal in a waste processing plant where dioxin emissions were involved. This seems to have deterred other paper and board producing companies in The Netherlands from investing in similar installations and from burning reject streams in their own energy generation processes. After ENCI stopped buying Rofire and the amount of PVC in the rejects was lowered with the aid of near-infrared detection, a new market was developed in the lime producing sector. The chloride content was lowered from 1.15% to less than 0.8%. The lime producing industry was willing to pay a higher price than ENCI was. Therefore, the developed Rofire production process can be called an innovative and economically attractive way of reusing material that, up until then, had simply been labeled as waste.

The Rofire project has contributed to the societal goals of reducing the dumping of waste, developing fuel from the paper and plastic fraction in industrial waste, and using this fuel to replace fossil fuels in other industrial burning processes. The project has also improved the efficiency of the company by reducing the costs of dumping and increasing revenues.

The Rofire project has contributed to greater sustainable development in several ways. The view has been developed that Company A does not exist solely for the production of board, but also for the recycling of paper. In this view, used paper is seen as a combination of valuable resources that form the basis of several marketable products, among which board. This view has been at the basis of the realization of the Rofire installation and product. It has stimulated discussions about the environment and business on a deeper level than before, both in the Provincial organization and in Company A. It has been supported by different actors in the social, environmental and economic networks of the company, and by the management of Company A. It stimulated new marketing efforts when the contract with ENCI came under pressure.

On the methodical level, temporary new platforms have been designed to realize the project, with new and unfamiliar participants. Even though actors with predominantly economic interests were in the majority and environmental organizations were excluded, the platforms have been seen to support the interests of actors from the social and ecological networks of the company.

Furthermore, the Rofire facility can be regarded as an improvement when compared to dumping the rejects in a landfill.

Looking back, the project has been very successful. The prices of dumping or burning waste have continued to rise, and this has increased the savings realized by Company A. Because of this development, the investment in the Rofire facility has paid itself back in less than two-and-a-half years. In the new market segment, the price of Rofire has slowly risen. Due to the high quality requirements on the used paper that is an input for the board factory, the quality of the rejects and the pellets is very stable. Rofire is seen as a very good secondary fuel that does not lead to process fluctuations and that helps to reduce CO2 emissions. The increased attention for CSR, sustainability and CO2 reduction has stimulated demand for the Rofire pellets.

Figure 6.1 Company A: The Rofire plant (source: http://www.risiinfo.com/db_area/archive/ppi_mag/2002/0206/ppi7.htm)

6.3 Company B: The Wetlaid project

Company introduction

Company B is a medium-sized company founded in 1935, with approximately 200 employees. It produces 42.000 tons of hygiene paper annually. 50% of the turnover of Company B is realized in The Netherlands, 30% in Germany, 10% in England, and the remaining 10% in other countries. The products it supplies are paper towels and toilet paper, and accessories for the washroom, like soap and towel dispensers. Company B aims to remain an independent company, in order to be flexible and fast in reacting to market developments.

Company B was one of the first companies that used de-inking technology, which enabled the input of used paper instead of virgin fiber. At the time of the interviews, used paper is the only resource and there are two machines operational, of which the one dating from the 1960s has been modified several times.

One of the two paper production machines (PM3) produces one-layered grey paper for towels: crêpe. The second machine (PM4) produces tissue paper that is softer, whiter and lighter than the grey one.

Company B developed a concept focused on building relationships with the wholesalers, accompanied by guarantees. The company takes return, at their original price, of the products the wholesaler cannot sell. Being a relatively small company itself, Company B is a natural partner for the smaller wholesale companies. The main competence that has contributed to the success of the company is its proximity to its customers: listening to them and reacting to their demands. Innovation and technological power were not part of their competence. Company B works on improvements using the SGA method (Small Group Activity): small and multidisciplinary teams that focus on specific subjects and develop improvements.

Company B is said to have a culture that is a somewhat traditional, and it does not try out new things very quickly. The employees know each other fairly well. Because of its size, communication lines are very short. Management is very accessible and departments are small. Management tries to inform employees as fully as possible on developments at the company through the monthly so-called ‘cascade meetings’. The employees are very involved in the company, and many have been working there for a long time already. The company is rooted locally, and it makes efforts to keep its people employed.

Case description

Company B was confronted with a declining market for one of its products. To counter this problem, it set up the Wetlaid project to modify the paper production machine and created a new, more water-resistant paper using a combination of cellulose and plastic fibers. Although, ultimately, an attractive market for the new paper could not be developed and the paper was not taken into production, Company B used the project to develop its own innovation policy and method; one that proved to be effective in other projects.

Figure 6.2 Company B: PM3 (source: Company B)

Problem description – company and societal issues

The Wetlaid innovation project stemmed from difficulties in the market for cheap, one-layered grey paper towels. This product, produced using one specific machine (PM3), was at the end of its life cycle. Demand had declined, the number of East European competitors had increased and decreasing price levels had made it hard to keep PM3 in operation. The company considered various options, e.g. moving the machine to Poland or dismantling it. PM3 could be modified to produce very different kinds of paper, but that would require major investment and PM3 would then be merely similar to the other machine in operation. None of these options was attractive, but Company B needed the production volume of this machine to cover its fixed costs. Therefore, management decided to try to develop new products that could be produced with PM3.

From this decision, the Wetlaid innovation project followed. The project was started in reaction to the company issue if keeping PM3 economically viable. The company also wanted to keep PM3 operational to maintain employment in the region.

Innovation processes

The General Director and the Director of Operations recognized changes in the market for one-layered, grey paper towels. They came to see that the profitability and future of PM3 were at stake and that innovation needed to be a core part of its market strategy. With innovation in mind, the General Director and the Director of Operations visited a professional trade fair, made new contacts, and created new networks.

Company B first looked at the possibility of converting PM3 to a dry production process, introducing fibers with air streams. This idea was put forward by the Director, who was trying to find ways to avoid the energy-intensive evaporation of water in conventional paper production. But dry production did not prove possible.

Usually, companies try to produce paper with different characteristics through the use of various drying techniques. Because this approach is very expensive, Company B wanted to experiment with a simpler technique, namely varying the fiber composition. It was the director’s idea to try a mix of cellulose and synthetic fibers. In the project called Wetlaid, management at Company B started to research the option of adding plastic fibers to the cellulose fibers.

The company talked with a former employee from another company who had worked on a similar product. Laboratory tests were performed at Hercules, a supplier to the paper and board sector, as well as tests on a pilot machine. These tests showed that it was possible to produce the new paper in a relatively simple way. Management then decided to try to produce Wetlaid on PM3.

Preparing the tests on PM3, Company B decided to work only with what was available on site and to keep the organization in its own hands in order to limit costs. Specialists from the Technical and Production Department designed the tests and presented them to the machine operators, FiberVison (the supplier of plastic fibers) and Hercules. This approach worked well in terms of involving Company B employees, supporting motivation, and improving the plans. Sales people were not involved in the tests or the preparation, due to traveling distances and lack of time. The tests were prepared and evaluated in technical work meetings.

In the tests, the normal route of the fibers through the pulper and pumps could not be used, because the fibers knitted together in the pumps. Company B still had an unused pulper that was then cleaned, installed with a new pump and connected to the PM3. In the pulper, the dry synthetic pulp had to be worked into the right condition.

During the tests, several runs were performed and gradually the team learned more and more about the most important parameters: the production speed, the weight of the paper, and the temperature of the second drying step. In this step, the plastics are melted together to form an internal web of plastic threads and to strengthen the paper. For two days in January 2005, tests were performed. All of the machine operators were present, contributing their knowledge and experience. Information was collected and experiments were modified step by step. All the effective process variables and machine adjustments had to be found and confirmed as they went along.

Employees of Company B participating in the tests were selected on the basis of their work experience, knowledge and problem-solving capabilities. There was a clear division of tasks. The Director of Operations and the Production Manager of Company B managed the test as a team, together with a representative of FiberVisions, the representative of Hercules in the field of functional chemicals and an Application Specialist from Hercules. FiberVisions and Hercules provided crucial expertise on fibers, chemicals and the paper producing process. The tests were seen as a cooperative effort that would not have been possible without the participation of any one of the parties.

Afterwards, the tests were evaluated with the whole team and the two shifts involved in the test. Additional tests were performed to find out the qualities and possible applications of the new Wetlaid material. The plastic fibers in Wetlaid created an environmental disadvantage, because the product was then no longer recyclable as paper. Therefore, Company B also looked for different applications for the material and at different kinds of fibers. Company B asked the consultancy agency Jaakko Pöyry to research the application of the Wetlaid material in polishing cloth, in the agribusiness sector, and as packaging material.

Wetlaid was twice as strong as ordinary tissue paper, but also twice as expensive. Gradually, the problem shifted from idea generation and technical aspects to the commercial side: can the new material be packaged as a marketable concept? When samples of Wetlaid had been produced, the General

Director got involved in market research and development, in cooperation with the assigned Sales Representative and the Director of Operations.

Gradually, the picture of the technical and commercial possibilities of Wetlaid became clear, and the market potential of Wetlaid proved not to be high enough. Therefore, management decided to stop the project. Activities aimed at large-scale production were never started. However, through its contribution to the development of an innovation philosophy, policy and tool, the Wetlaid project did generate new value and meaning for Company B and can thus be characterized as an innovation project.

Organizational structures

The organizational structures did not have any names other than project team or work group, and their composition changed in the course of the project.

At the beginning of the project, the General Director, the Director of Operations and the Production Manager worked together in regular management meetings on problem observation and definition, and on strategy and policy development. A tool was developed (Innovation Funnel) to help structure ideas and the management of various innovation options and trajectories.

All employees were informed of the problematic situation with PM3 through regular Cascade meetings. In these meetings, employees were informed about the policy, projects and results of the company. The employees were also asked to contribute ideas for alternative products for PM3. Ideas were also developed in regular informal consultations on the work floor.

The main organizational structure for managing the project and for the development of Wetlaid was the project team. This team initially consisted of the directors and the Production Manager. In a later phase, specialists in process technology, the operators, and specialists from the supplying companies Hercules and FiberVisions also participated.

Tests on PM3 were prepared in regular technical work consultations. One of the six account managers was brought in at a later stage. The project was part of the Balanced Scorecard and it was monitored in regular management meetings and in talks between the Production Manager and the Directors. After the tests, a new smaller group was formed for market research and development, and a contract was signed with Jaako Pöyry to carry out market research.

Actors

Multiple organizations, managers and specialists contributed to the Wetlaid project. In Company B, the General Director and the Director of Operations worked together with the Production Manager, the specialists from the Technical and Production Department and an account manager from the Sales department. The suppliers, Hercules and FiberVisions, contributed to research and development. Jaako Pöyry performed market research for Company B.

Outcomes and further developments

The Wetlaid project is regarded as having been an enlightening experience for the people involved in terms of finding out that using only simple means it was possible to produce a new material - Wetlaid. The feeling was: we are doing something unique, something that has never been done before on this machine.

The Wetlaid material was strong, but not soft and rather bulky. It could contain between 5% and 25% plastic fibers, depending on the application of the material. Wetlaid proved to be strong enough for cleaning windows and fit for use as a polishing cloth. Company B also produced rope made of Wetlaid, but its strength was not sufficient. Six rolls of Wetlaid were produced. Production of larger quantities would have required bigger investments, e.g. in pumps.

The production of Wetlaid was costly because synthetic fibers are expensive. The question was whether or not it could be produced cheaper, and if the price would be high enough to improve margins. In the later phases of the project, a work group was set up to research the potential of Wetlaid in the market. Because this research was done in cooperation with potential customers, planning was very difficult and there were no funds to assign people to market development.

Within the company, it is seen as an advantage that the paper makers, operators and technicians were involved in the development of Wetlaid and in the tests. Their practical attitude and experience complemented the knowledge of management. As a result, this way of working has since been implemented in the development process of other products at Company B. The result is that new possibilities have also been discovered for PM4 (the second machine at Company B), and that the range of papers it can produce has increased.

In the end, the company decided to stop the Wetlaid project because there was too much competition from other producers in the market. However, on the philosophical level, management has developed the view that the company is able to innovate and is even better equipped to take on this task than its very large competitors. This change of company philosophy and formal policy has stimulated processes of idea development, experimentation and testing within the organization, and has stimulated the creation of new contacts, networks and cooperative alliances.

On the methodical level, a new tool, the Innovation Funnel, has been put to use to monitor idea development and progress in innovation projects. Also, the use of the existing communication method of 'cascade meetings' has been extended. It has become a tool for management not only to send information, but also to receive questions and ideas. The company has developed organizational structures and work methods to improve the participation of employees in research and development. Company B now works with innovation teams that report to a sounding board, in order to keep the innovation processes ongoing and effective. The finding in 2006 is that there are plenty of ideas, but that not enough of them are being realized.

The new innovation philosophy and tool that have been developed have dramatically altered the self-image of the company in relation to innovation. This has supported renewal and improvement in the company. It has helped the company to produce a Cradle to Cradle certified toilet paper and has improved its competitive position.

The problem with the economic viability of PM3 has been solved in a different way. A new and profitable market abroad has been found for the cheap, one-layered grey paper towels, and the company has stopped selling the grey towels to a number of customers with which only low margins could be realized. Thirdly, part of the production capacity of PM3 is now dedicated to the production of white tissue paper. So, the problem with PM3 has been solved by changing the mix of customers, markets and products.

6.4 Company C, project 1: The Task Force Ruptures

Company introduction

Company C is an independent, medium-sized Dutch firm with nearly 300 employees. Per year it develops, produces and sells approximately 200.000 tons of high-quality specialty products. The company services several different markets so as to spread risk. It works together with its customers on a technical level in the development of new products.

Because Company C is an independent company, decisions can be taken very quickly. The interviewees mention that management is open to discussing problems and the General Director is described as very approachable.

Innovation in Company C is defined by the General Director as "*the creation of new combinations*". These do not need to be absolutely new or to be realized only in large-scale projects. Innovation can be in small, incremental improvements that lead to greater improvements. In Company C, several improvement processes usually run parallel to each other.

The company is dealing with the problem of the rising average age of the workforce, which is now 43-years old. Because it is the culture in the paper and board industry that employees work their whole life for one company, it is not unusual that men at the age of 59 or 60, after 40 years of service, still work in five shifts. Until recently, only one or two employees would leave the company each year. However, this pattern seems to be changing. The company aims to develop internally the quality of its workforce. In the past, a new employee started at the bottom of the organization and had 25 years of experience behind him before he became a foreman. But now, new employees, usually 18-years old, are expected to leave within six or seven years, and therefore education and training in the company have to change as well. For specialized functions, two years of education is necessary. But not everyone has the capabilities required and this increases work pressure.

Many people in the organization have been trained to use the Kepner Tregoe improvement method, and efforts have been made to train people in project management. For the rest, technical education is predominant, and it is reported that good communication usually does not feature as a characteristic of managers and employees. This aspect of the culture is seen as a risk. It is thought to promote one-sided views and misunderstandings. For example, technicians from the technical department do not always contact the operators in the Production Department to discuss problems. It is reported that it is down to the individual whether he contacts colleagues to speed things up or not.

Case description

Company C experienced serious disadvantages in the development of new products due to frequent ruptures in the flow of paper in the paper production machines. To improve the situation, a multi-disciplinary Task Force Ruptures (TFR) was set up, dedicated to researching on a daily basis the causes of all ruptures and coming up with design improvements. The TFR discovered many different causes and managed to develop and implement solutions. Finally, product development could go ahead again. However, after the TFR was dissolved, the number of ruptures increased once more.

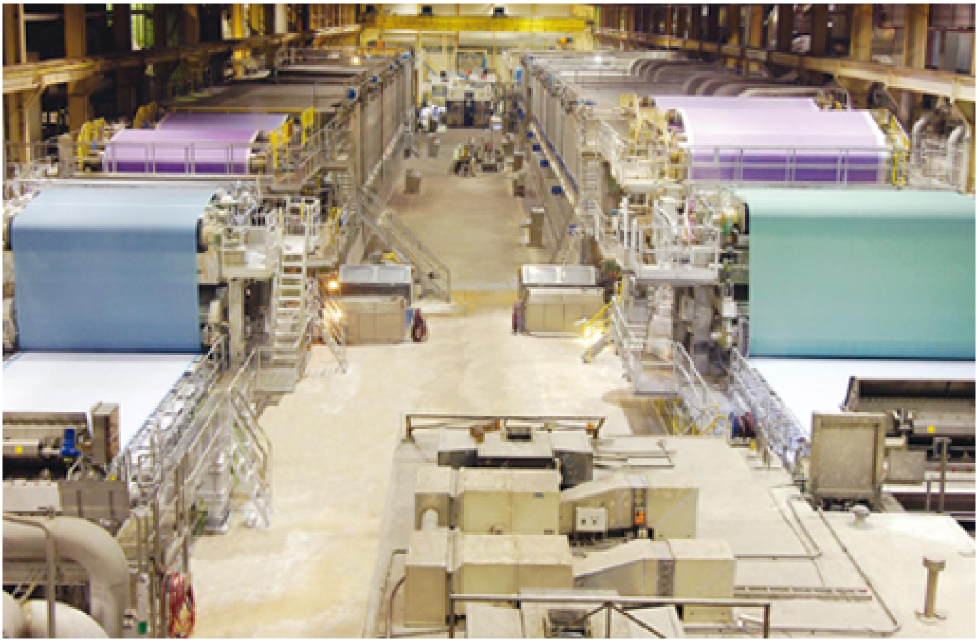


Figure 6.3 Company C: PM1 and PM2 (source: Company C)

Problem description – company and societal issues

The Task Force Ruptures was started solely in response to company issues, not societal issues. These issues are described below.

Company C operates two paper production machines: PM1 and PM2. They can produce 5 to 20 tons of paper per hour. Each machine produces several kinds of paper, ranging in weight from 50 to 170 grams. To do this, the machines have to be adjusted regularly. The adjustments generate changes, e.g. in speed or in the width of the paper, and these cause stress in the flow of paper. This stress can then cause ruptures in the flow of paper. In addition to this, during maintenance of the machines, parts are cleaned or replaced and settings are sometimes changed unintentionally. These actions are also the source of ruptures.

In May 2004, PM2 was modified to increase its maximum speed by 15% to 1000 meters per minute. However, after the modification it became clear that due to the ruptures the new norms were not being met. On average, nearly three hours per day were spent on repairing ruptures. This meant that the return on the investment in PM2 was not realized.

Ruptures have several negative effects. These include immediate loss of production time and quantity, and the loss of production time limits the available time to do tests for product development. When production starts again, it takes time to bring the paper up to the desired quality and, in the meantime, resources are wasted. As a consequence, costs rise. Starting production anew also causes pollution in the machine, and this can cause new ruptures.

The frequent ruptures generated dissatisfaction and discussions, and product development was slowed down. To improve the situation, the Task Force Ruptures was set up on June 18, 2005 and continued in existence until the last quarter of 2005.

Innovation processes

The Technological Department brought up its dissatisfaction at the situation. In informal talks between various specialists and managers, the idea of the Task Force Ruptures was developed. The Technology Department and the Production Engineers were at the centre of these discussions. In the daily Morning Management Meeting, it was concluded that the number of ruptures and the related losses were unacceptably high. It was suggested that ruptures should be analyzed more deeply to find the root causes, and the idea was developed of forming a task force to improve the situation: the Task Force Ruptures (TFR). Every day, the ruptures on PM2 would be analyzed in depth on the basis of process data.

This was a new approach. Up until then, a rupture was regarded as "*An act of God*" (Company Manager), partly due to the lack of a means for gaining a deeper insight. The mess was cleaned up and people returned to business as usual. No collective insight into the causes of ruptures was built up. From the moment the Task Force Ruptures was operational, it developed a method to research ruptures, to discover their causes, to design solutions and to prevent ruptures in the future. After a rupture had occurred, the TFR collected information on the rupture and the process variables on the paper production machine. One source of information was the pictures from high-speed cameras inside the paper producing machines. A second source was the Real Time Data Base (RTDB) in which the data from 1000 to 1500 tag-points was stored. Each of these tag-points collected process data on a continuous basis.

After the TFR had been operational for some time, patterns became clear, so new ruptures could be categorized and solutions could be discovered more easily. The analyses increased the speed of the learning process.

In cooperation with the Foremen, their assistants and the Operators, standard computer displays were designed with overviews of important process data. When a rupture occurred, the Operators first studied these graphics to see what had happened. Thus, Operators became capable of analyzing the causes of a rupture on their own. Different shifts, however, continued to work in different ways, and not every Operator had an affinity with computers and the displays.

In addition to analyzing pictures and process data, the TFR and other people in Company C were trained to use the Kepner Tregoe improvement method in order to better understand problems. This method was known throughout the whole company and helped to optimize problem analyses.

Because of the multidisciplinary nature of the TFR, different kinds of measures were designed. Some measures were of a technical nature, e.g. the construction of a bar in the machine to prevent dirt from falling on the paper. Other measures focused on changing work routines, e.g. the habit of a shift to add water without fibers to the pulp. Changing work routines proved to be the most difficult task.

Organizational structures

Several organizational structures can be distinguished that contributed to managing and further developing the multidisciplinary approach of the TFR. First, informal meetings took place between managers and specialists, e.g. in the hallways, in which the problem of the ruptures was discussed. From these talks, the subject was brought to the formal daily Morning Meeting. The function of this meeting was to discuss issues concerning production and technical or technological developments. Participants included the Company Manager, the Production Manager, the Manager Logistics, the managers of the Technical Department, the Technological Department, the Quality Department, and at least one Production Engineer. Sometimes a foreman attended the meeting.

In the Morning Meeting it became clear that the present organizational structures, under the pressure of daily work, were not sufficiently effective to solve the problem of the ruptures. It was decided to make three specialists from the Technology and Technical Departments available in a full-time basis for a limited period of four weeks to form a specialized multidisciplinary Task Force Ruptures.

The task force consisted of two Process Technicians and a Production Engineer. It was set up on June 18, 2005 and continued in existence until the last quarter of 2005. In the beginning, the TFR met daily. Each morning, the Task Force analyzed the ruptures and then met with other departments at noon to discuss the findings and decide what action should be taken. This meeting was called the Ruptures Meeting. Participants included the Company Manager, the Manager Production, other Production Engineers, a Project Engineer from Control and Instrumentation, a Foreman, and sometimes another specialist, depending on the causes of the ruptures. At a later stage, because of the work pressure around noon, the Foreman was informed in the afternoon about the findings in a separate talk. Depending on the number of ruptures and the findings, the Ruptures Meeting could take one hour or the whole afternoon. Most of the time was spent on integrating the data and trying to understand the underlying causes of a rupture. From November 2005 onwards, the TFR met twice a week, though sometimes a meeting was skipped because of a lack of new findings. Later on, due to the refurbishment of the paper machines, product development and other projects, the three specialists were no longer available full-time for the TFR.

Communication with the shifts about causes of ruptures was seen as very important to the implementation of improvements. If a Process Technician discovered a new cause, he approached the foreman and the operators and informed them. Showing the findings created a direct learning effect in the shifts. However, it was not possible to speak directly to everyone in the five shifts, and therefore the findings and improvement actions were issued in writing or placed on the intranet each day. Also, in every shift a specialist was trained to use the standard computer displays to gain insights into the ruptures. Meetings with the shifts continued on a weekly basis, and various subjects related to ruptures were discussed. The TFR found it very important to inform the shifts directly and to discuss the findings face-to-face.

Not all of the organizational structures were designed at the beginning of the project. The TFR and the Ruptures Meeting were planned: the chat with the Foreman in the afternoon, the information meetings with the shifts, the informal meetings on the work floor, and the expert groups for analyzing ruptures were all developed during the project.

I found four different kinds of processes that contributed to the design or improvement of organizational structures. A new ruptures management strategy was developed, and it was also decided to start a task force. Then there was the process in which the composition of the team of the TFR was decided upon. I also found that Production Engineers and Process Technicians had to regroup their tasks in consultation with their managers and colleagues in order to be available full-time for the TFR. And finally, I distinguished a process in which the Ruptures Meeting and meetings with shifts and operators were developed to discuss the findings of the TFR.

Actors

Several internal actors were involved with the TFR. First off, a Production Engineer participated in the task force - a trouble-shooter with the most knowledge about the machine. Furthermore, two Process Technicians from the Technology Department were involved in product development. Their task in the task force was to analyze ruptures and to find the root causes. In the Ruptures Meeting, staff from other departments joined the TFR: two other Production Engineers were involved in the implementation of measures; the Production Manager, supervising the Production Department; and the Company Manager, supervising the Production Manager and the Technical and Technology Department. The Foremen of the production shift participated in the first meetings of the TFR. Sometimes another specialist was invited, depending on the part of the production process that was being investigated by the TFR.

The people in the various shifts were informed about new insights into the causes of the ruptures, about changes in the production process, and about the new instruments that the TFR developed. The General Director of Company C was informed by the Company Manager about the work of the TFR. The Head of the Technology Department decided on the budget for the TFR.

The Task Force Ruptures consisted of internal actors only. When specific improvement plans had been developed by the task force, sometimes a supplier was involved to assist with implementation. But mostly, the problems were too specific for suppliers. Members of the TFR, when talking with specialists from other companies in the sector, were always alert to new knowledge about approaches to preventing ruptures.

Outcomes and further developments

Slowly, after two or three months, the TFR was able to achieve deeper insight into the causes of ruptures, and the number of ruptures decreased. In total, between 30 and 40 different causes of ruptures were discovered, originating from irregularities in the process parameters and in work routines. In the beginning, multiple causes were identified per rupture. Later on, the ruptures were easier to solve because the causes were more unambiguous in nature.

The shifts were informed about causes, and sometimes foremen and operators were instructed in different ways of working. Some shifts started to use the RTDB, the camera system and the standard computer displays. In the process, the TFR discovered, for example, that PM1 was much more sensitive to dirt than PM2. The TFR learned to discern whether a rupture had a single cause or was of a more complex nature. The organization has become much more alert to problems, and tends to react to them faster. Consciousness has been developed among management that it is necessary to have other groups of professionals (outside the TFR) cooperate more with each other in order to increase their effectiveness. It has also become clear that it is necessary to better facilitate and educate the foremen, and that improvements depend on successfully changing patterns in work routines. Ideas have been developed about the way the shifts are informed, and about additional education.

On the philosophical level, the view that ruptures are "*Acts of God*" has largely been changed through the performance and results of the TFR. On the methodical level, a method of multidisciplinary analysis and idea generation that was new to the company has been devised. On the instrumentation level, the TFR project has generated new tools (the Real Time Data Base, videos of ruptures, and standard graphics) that the operators can use to prevent ruptures and to discover the sources of ruptures.

However, at the time of our interviews management was not satisfied with the results, for various reasons. Both methodical and philosophical results seem to have been largely temporary, as they have not yet been formalized in company policies and work methods. The shifts' ambition was also not all that high yet; they still accepted ruptures as an unavoidable phenomenon. Researching the causes of ruptures is still not done sufficiently by the Production department. Rupture analysis is still done by people outside Production, reportedly because guidance has been insufficient.

There has not been a conscious decision as to what the future of the Task Force Ruptures will be. At the time of the interviews, the TFR was only meeting sporadically. Other priorities had called team members away, and the number and complexity of ruptures was rising again. So, we conclude that the project has contributed temporarily to an improved productivity.

6.5 Company C, project 2: The DLE project

Case description

In this project, a conventional gas turbine in the combined heat and power installation of Company C was replaced by a more environment-friendly Dry Low NOX Emissions (DLE) gas turbine in 2005. The replacement was forced by pressure from the provincial authorities, based on EU legislation. The company had to combine the project with several other ones to make it possible, and it had to reinvent its project management methods.

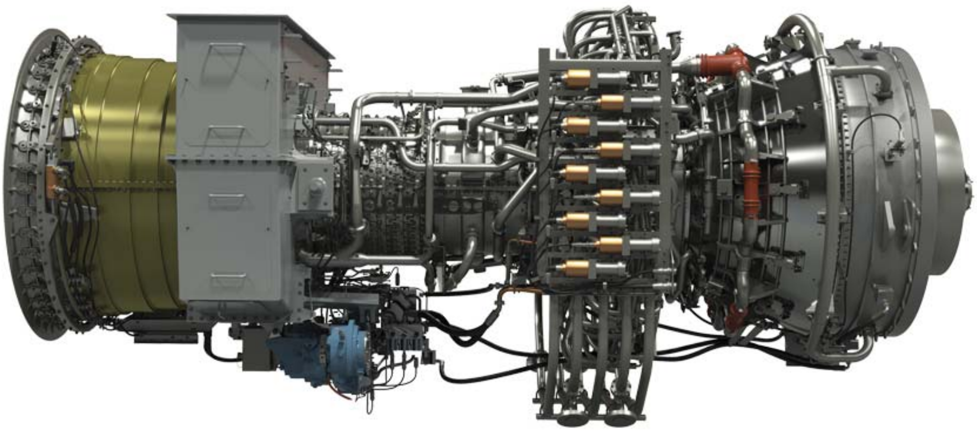


Figure 6.4 A DLE gas turbine (source http://www.ecomagination.com/portfolio/lm6000-pf-aeroderivative-gas-turbines)

Problem description – company and societal issues

Company C used a General Electric gas turbine to generate heat and power for its paper production machines. At certain moments this turbine created NOx (nitrogen oxide) emissions above the legal environmental limits, for example when a rupture in the paper flow had stopped a paper production machine. In an environmental permissions procedure in the years 1999 and 2000, Company C and the Province had agreed that this situation would temporarily be allowed, on the condition that the yearly average NOx emissions would be below a certain limit, that emissions would be monitored every 15 minutes, and that the machine would be replaced before July 1, 2005 by a more modern one that would enable adherence to the stricter IPPC norms. The date July 1, 2005 was chosen with the expectation that the turbine would be then at the end of its economic life span.

However, between 2000 and 2005 the situation changed considerably. The technology to produce steam had become more energy efficient, and the amount of steam needed for paper production decreased considerably. The capacity of the turbine was more than sufficient. Furthermore, Company C had hoped that trade in NOx emission rights would be initiated, and that buying these rights would help Company C to adhere to the norms. This trade was started, but it was set up next to the legal norms instead of replacing them.

In 2004, there were several issues that forced Company C to take action. First, the turbine had been operational for 20 years. The control system of the combined heat and power (CHP) installation was outdated, and components and expertise were difficult to find. Retired specialists were maintaining the system, and that was considered too great a risk. Secondly, the turbine urgently needed maintenance. And thirdly, the boiler in the combined heat and power installation had to be inspected. In addition to this, the gas turbine had been running for more hours, albeit without much trouble, than any other GE turbine in the entire world and it was at the end of its technical life span.

Company C and the Province had differing views of their agreement. Company C thought that they had agreed that the turbine would be replaced by a modern one at some point in the future. The Province believed, however, that July 1, 2005 was the final deadline for the replacement. The result was that, in 2005, Company C was not planning to replace the turbine with a more modern one, but rather with a second-hand turbine of the same type. That would enable Company C to meet emission norms. This plan would required an investment of approximately 6 million Euros, while a new gas turbine would cost 50% more.

In January 2005, Company C wrote a letter to the Province asking for approval to go ahead with the secondhand replacement. In reaction to this request, the Provincial environmental officer studied the agreement that had been drawn up in the past and concluded that the company, on the basis of IPPC, was obliged to replace the old turbine with a modern one of the Dry Low NOx Emission (DLE) type.

When the Province reported this to Company C in 2005, the company protested. The company felt that it was being treated differently to airline companies who use the same turbines in their planes and who were not obliged to replace them. And, the available budget was not sufficient. However, its hand was forced by legislation and Company C eventually had to purchase a new DLE turbine.

Installing the new turbine was a major operation that forced the factory to stop production for a period of several weeks, and that also required the company to simultaneously address a number of maintenance, automation and improvement issues.

The combined heat and power installation was operated by a total of 17 workers, and company management was keen to reduce that number. Also, the analog control systems of the installation were outdated. This led management to the decision to further automate the installation so as to make it operable by one single employee per shift. Also, the boiler needed to be inspected and maintenance had to be carried out. These automation, inspection and maintenance projects were to be undertaken in the same period as the replacement of the gas turbine. Saving on energy was an important matter for Company C in terms of improving the production efficiency and removing a bottleneck for the growth of paper production. With this goal in mind, an Investment Master Plan was up and running on PM2. It was decided to implement the energy-saving measures when the gas turbine was being replaced. PM1 would also be modernized. The result was that four major projects, with a lot of mutual interaction, would have to be executed in the same timeframe.

Innovation processes

The idea of replacing the gas turbine with a turbine of the DLE type and combining this project with three other projects in the same time period was developed through the contributions of several parties in and outside Company C.

Company C management and the coordinator of environmental affairs asked the Province to approve the replacement of the gas turbine with a secondhand one. The Industry Desk at the Provincial Authority researched the request, and studied the most recent and relevant environmental legislation, and then formulated its demands. The consultancy agency Stibbe advised Company C in its efforts to understand the limits of the relevant legislation. KEMA advised Company C in the research of the automation project. The Board of Directors of Company C examined the investment proposal. The Workers Council of Company C discussed the effects of different automation scenarios with Company C Management. GE assisted Company C in planning the replacement project.

After the Provincial authorities notified Company C that it had to take action to adhere to the emission limits, a phase of research began. First, the company studied in-depth the applicable laws. Then it studied the various scenarios for the long-term development of the company and its expected steam and electricity needs. It concluded that it wished to continue looking after in its own energy supply. Company C's preferred option was to install a secondhand turbine or, failing that, to continue to operate the existing one. Research by KEMA showed that a turbine replacement would take up to four weeks. The research also made clear that a new DLE gas turbine would generate some advantages. Rising energy prices made a more efficient turbine financially attractive. The extra investment would be recovered in six to seven year's time. In the end, this option turned out to be the most advantageous.

Although installing a new gas turbine was a complex operation that would require significant reconstruction, in January 2005, after discussion with the Board of Directors, it was decided to give it the go-ahead. The new gas turbine would be installed in November 2005, and in April 2005 Company C was forced to take an option on a DLE gas turbine that General Electric was building at that moment.

Because it was important for Company C to minimize the effects of the production stop, General Electric was pressed to replace the turbine in as short a space of time as possible. However, GE and other companies had indicated that a period of six weeks would be needed because GE was not used to rebuilding installations under pre-existing conditions. It usually worked on 'greenfield' projects with completely new installations. In addition, GE in the Netherlands mainly carried out sales activities and did not have the required engineering capacity. However, Company C was of the opinion that GE should be able to take the responsibility for completing the work in a shorter time period. Therefore, a rebuilding period of four weeks was agreed upon. In reality, the project would take six to seven weeks to complete.

On November 14, paper production was stopped and the rebuilding projects were started on the paper production machines, the combined heat and power installation and the gas turbine. The projects were executed in the weeks 46, 47, 48 and 49 of 2005.

I was able to distinguish several innovation processes in the project. Problem observation and definition have occurred in Company C and at the Provincial licensing authority when approval was requested for replacing the old gas turbine. Different issues were considered from the perspective of the company and of society. Both the Company C managers and the Province developed ideas for coping with the expected problems. Company C developed ideas on alternatives for the replacement of the gas turbine.

Next, Company C carried out research aimed at understanding the relevant environmental legislation, exploring the possibility of circumventing the obligation to purchase a new gas turbine, charting the various alternatives and gas turbine replacement options, gaining insights into the technical consequences of the purchase of a DLE-gas turbine, and examining the feasibility of combining four projects in the same time period at the end of 2005. The licensing authority of the Province researched the details of the agreement with Company C from the year 2000, and the relevant norms and legislation.

The diverse research findings and options were discussed by all the parties involved. The understanding developed within Company C that the purchase of a new DLE gas turbine, combined with the execution of three other projects at the same time, was the preferred option. A deadline was agreed with the Province for the replacement of the turbine. The option of the combined projects was then designed, planned and organized in close cooperation with GE and other suppliers in the spring and summer of 2005.

Finally, the four projects (the DLE replacement project, the maintenance and automation of the combined heat and power plant, the addition of energy-saving measures on PM2, and the modernization of a part of PM1) were executed in the last weeks of 2005.

Organizational structures

The fact that four interacting projects were to be executed in the same short period of time, in cooperation with various outside companies, demanded careful attention with regard to project management. The following organizational structures were involved:

The Provincial Licensing Authority used formal licensing procedures as the structural basis for communicating with Company C. Through these procedures, the replacement of the gas turbine was identified as a societal issue.

Under the pressure of the circumstances, it was an advantage that decisions in Company C could be taken relatively quickly. This was down to the fact that the company has an independent ownership structure and is not part of a multinational.

The Workers Council was involved in helping to develop and discuss different combined heat and power automation scenarios.

Monthly Project meetings were held in which all of the investment projects were discussed. Participants included the General Director, the Company Manager, the managers of the Technical, Technological and Production Departments, and the Strategic Projects Manager.

In the Project Buying Team meetings, the same participants met, along with the Purchasing Manager and an external Projects Manager. The team was part of Investment Master Plan 2 and worked at managing the four subprojects. The meetings helped to spread the lessons learned in projects, to combine knowledge in order to solve problems, and to take decisions without any delays.

Safety meetings were organized to ensure that the safety people were instructed, and contracting companies were obliged to write or update safety plans.

Four special project groups were started, with three Project managers. The workgroups met on a daily basis. In the groups, Kepner Tregoe was used as a tool for risk management and decision taking. It helped to weigh up different scenarios, to foresee problems, to analyze complex situations, and to develop solutions.

Although, at first, General Electric objected, it operated as the main contractor for the gas turbine replacement project. GE worked with a local subcontractor but had a project leader in Houston, USA who visited the Company C site once a week. The company had outsourced a large part of the activities to a Norwegian company that hired a Dutch company that, in turn, outsourced activities to various other companies. This cooperation structure created long operational communication lines, while the Company C project leader communicated directly with the GE project manager in Houston. As a result, misunderstandings developed between Company C and GE. Within GE, the communication between three locations across three time zones (Rheden, London and Houston) demanded a lot of coordination.

During the projects, Company C found out that the support of the Purchasing Department was insufficient, and an external contract manager was then hired. Their Purchasing Department was hindered by the fact that it had not been involved in the preparation of the projects and lacked the required knowledge. Company C also lacked a standard format for project reports.

Actors

The combination of the gas turbine replacement with other projects made necessary the involvement of many internal actors in Company C. The Director consulted the Workers Council, as the automation project would necessarily lead to a reduction in the number of employees. The Sales Department was involved because delivery to clients had to be guaranteed. The Finance, Purchasing and Personnel departments were involved. The Personnel department took care of educational facilities and catering. The General Director, the Company Manager, the managers of the Technical, Technological and Production Departments, and the Strategic Projects Manager were all involved. The three Project Managers were very influential, as they managed and coordinated the four combined projects. Also, the Operators and Foremen in the Production Department were involved.

Various external actors were involved. Company C did not have enough employees to execute the combined projects, and it lacked specific expertise. The Provincial authorities were involved because of the environmental legislative aspects. Company C asked the legal consultancy agency Stibbe for advice. General Electric was the most important external actor. GE hired the Norwegian company Mjørud, who then contracted GTI and Daalman for various engineering activities. KEMA was involved in researching the turbine replacement options; Aegis for contract management; Tebodin for expertise on gas pipes; Gasunie to audit the safety of the gas installations; Invensys for the supply and installation of the measurement and control equipment in the combined heat and power installation; Holec for the revision of the boiler; Brusch for maintenance of the generators; Sulzer Repco to overhaul the steam turbine; Jacobs supplied a project manager; and several more subcontractors were also involved. In the project on the two paper production machines, Voith was involved as the most important supplier. ABB supplied the control system for PM1. Siemens supplied a new motor control centre. The companies Jacobs, Aegis and Play Fair provided specialists in planning, project management, reporting, contracts and document control. Bosman en Bronkhorst supplied electro technical installations and expertise.

Outcomes and further developments

In December 2005, the DLE gas turbine was installed successfully. The DLE turbine was delivered two weeks later than scheduled, but it was not yet regulated properly and it suffered regular failures over a period of three to four months. This prompted Company C to claim several fines from GE. There was no trouble starting the paper producing machines after the projects had been finished.

The company has found that with the new DLE gas turbine energy efficiency has increased, which is seen as a major advantage in a time of rising energy costs. The combustion process in the turbine has become more efficient, and there is no longer any need to produce four tons of steam per hour to prevent NOx emissions. This has also helped reduce energy costs.

Another outcome of the project has been that the relationship with the Provincial authorities has improved and has become less complicated. With the new turbine it became technically impossible to exceed NOx emission limits. As a result, reporting requirements and time-consuming discussions were no longer necessary.

One effect of the pressure exerted by the Provincial Authorities to invest in a DLE turbine was that Company C started to search for new ways to reduce its costs. It has invested in the automation and digitalization of the controls for the combined heat and power plant, thus saving on the personnel costs of 10 employees.

The automation of the combined heat and power plant was seen as an innovative step, because the plant was not initially designed for automated operation and limited supervision. However, the DLE gas turbine was, at that time, simply the best available technique and cannot be regarded as an innovation. Company C had to innovate in the fields of communication, organization and project management – a pre-requirement for running the four interacting projects 24 hours a day over the course of several weeks.

The main lessons learned from these projects were the following. Company C has learned to manage projects like an engineering company. This knowledge has been put into practice in internal technical projects, and also in new business development. The company has learned to hire outside expertise to complement its own workforce and to make sure that projects are rounded off in a satisfying manner on all levels. Company C has learned that projects need sufficient preparation time and that time is needed to check and double check arrangements. Realistic planning is crucial to creating attainable goals. The message from one of the suppliers (in this case GE) that the company did not have enough experience in a particular field of work, had to be taken seriously. Another lesson learnt is that it is wise to invest in improved document control and in intensive contract management, in order to be sure that agreements are met. An extra facility for producing steam was worth the investment, because production could be started again on time. One of the most important lessons learned was in the field of communication.

On the philosophical level, company management has learned that the pressure exerted by the Provincial Licensing Authority and seemingly conflicting issues and interests can lead to advantageous solutions, both at the economic and the environmental level. On the methodical level, two of the Project Managers have introduced more structured methods of project and contract management. These have helped the company to develop new ways of multi-actor cooperation and systematic project management for complex and large projects. On the instrumentation level, Company C has installed a more energy-efficient gas turbine with low NOx emissions. The project has resulted in the application of a ‘best available technology’ that reduces energy usage and harmful emissions. The goals of guaranteeing the operation of the CHP facility and modernizing the controls have both been realized.

6.6 Concluding remarks

The interviews in each project generated data that allow for detailed comparison of the projects. In the Rofire and DLE projects, societal and company issues were involved; in the Wetlaid and TFR-projects only company issues. All projects applied several innovation processes and developed new or existing organizational structures. External actors participated in all of the projects, with the exception of the TFR project. The Rofire project generated a new product and production process. The DLE and TFR projects generated improved production processes, and the Wetlaid project led to an improved innovation philosophy and method that delivered pay-offs in a later, new project. The details of the applied managerial capabilities and their development have been compiled per interviewee in reports that are not part of this thesis.

In the next chapter, the data is analyzed by applying the four main aspects of innovation projects that I identified in section 3.7. This results in an overview of First Order Concepts, Second Order Themes and Aggregate Aspects. In chapter 8, cross-case analyses are performed that generate the material for the answers to the research questions, the conceptual model of the dynamics of inter-organizational learning for innovation (chapter 9) and the theoretical insights and recommendations (chapter 10).

7 Analysis, and the construction of Aggregate Aspects

7.1 Introduction

Chapters 1, 2, 3 and 4 served to introduce the aims of the research (i.e. to develop an understanding of the differences in the learning processes and results of different kinds of projects, to clarify the applied managerial capabilities, their developmental factors and their relation with learning and management satisfaction, and to develop a conceptual model, theoretical propositions and recommendations), to explain the meanings of the terms used, to introduce literature research, critical observations and the research questions, and to specify the research philosophy and method. In chapters 5 and 6, the paper and board producing sector, the companies and the projects were presented. In this chapter, the projects presented in chapter 6 are analyzed using a combined deductive and inductive approach. I applied the following procedure.

As explained in chapter 4, to make the data more accessible for the analyses, I have marked all parts of each interview that related to the contributions of interviewees to the innovation processes, the capabilities they applied, and the developmental factors of these capabilities. Then I focused each of the analyses in 7.2, 7.3 and 7.4 on one of the identified aspects of innovation projects that I identified as most important in chapter 3.7 (i.e. the innovation processes; the actors, networks and collaborations; and the managerial capabilities). Thus, within each theme, First Order Concepts were constructed on the basis of which Second Order Themes and Aggregate Aspects could be identified. Below, in figure 7.1, I present a picture of the different construction phases. In section 7.5, I give an overview of the outcomes.

'Aggregate Aspect' is the term that I use to indicate a specific aspect of the innovation projects, e.g. innovation processes, learning system or capability development. Each aspect flows forth from the division of the interview data in three main themes, as explained in section 3.7. Each aspect is 'aggregate' because it comprises different (First Order) concepts and (Second Order) themes, as will be explained in the sections below.

In chapter 8, cross-case analyses are presented, highlighting the main differences between the projects. The cross-case analyses have been structured along the Aggregate Aspects developed in chapter 7.

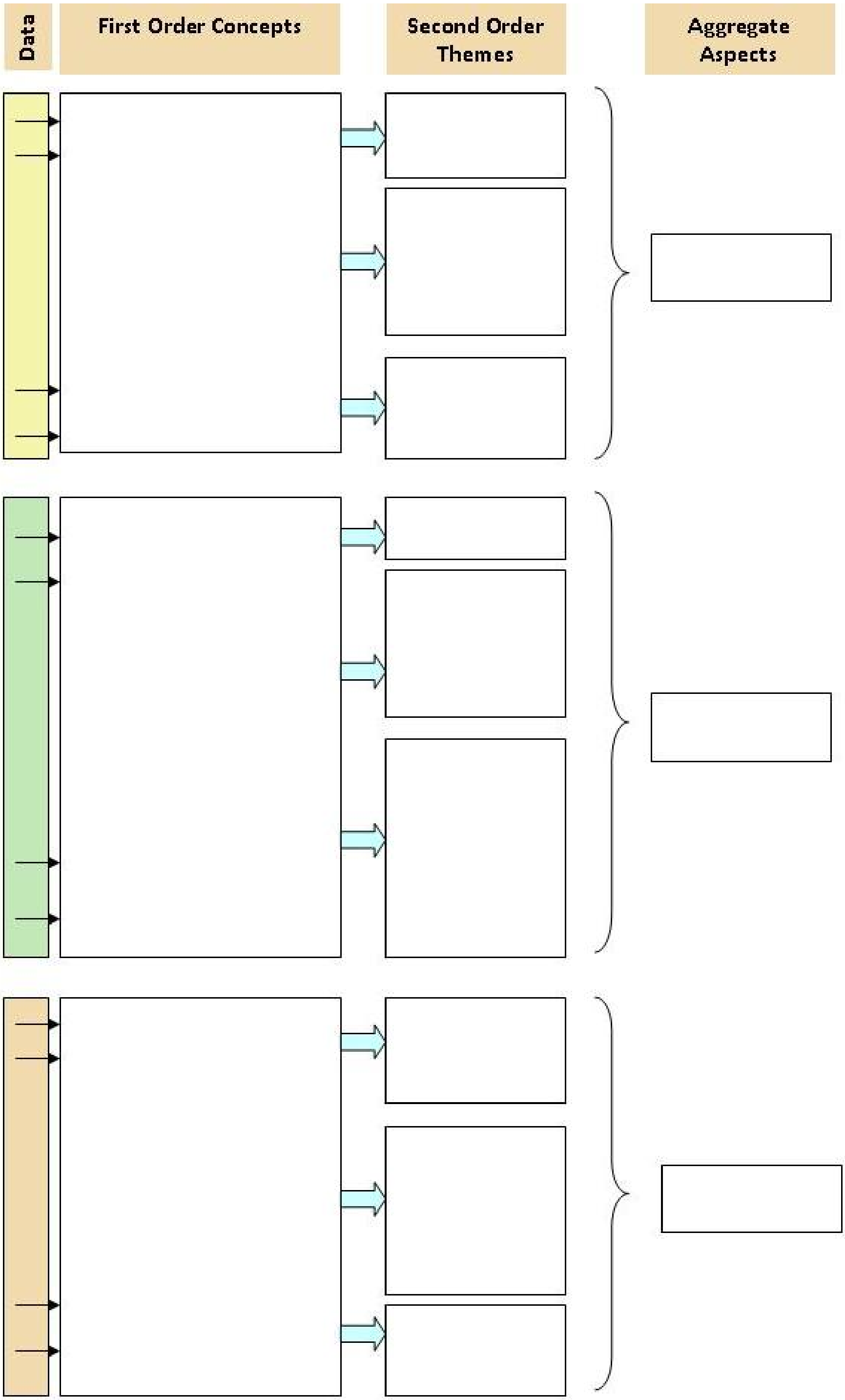


Figure 7.1 The construction phases of the Aggregate Aspects

7.2 The innovation processes

Interviewees from all of the innovation projects paint a picture of the activities they have undertaken to realize the new or improved production process or product. Analyzing the interviews, I found seven First Order Concepts that cover these activities, from problem observation to implementation, that are common to all projects. Examples of the First Order Concepts from the four projects and their relation to the Second Order Themes are given in Table 7.1.

In each project, managers, employees and other actors were engaged in first observing and then defining company and/or societal issues. Concrete issues have stimulated all projects. I rank these activities under the concept of problem observation and definition.

Through the observation and definition of the issues, processes were stimulated in which ideas or concepts were developed for new policies, production processes, products, markets, improvement methods or projects. I call these processes idea and concept development.

Once the initial promising ideas and concepts had been identified, managers and specialists started to perform different forms of research and development. These were focused on studying the (company and/or societal) issues, their different (economical, technological, social, ecological) aspects and possible solutions; on reconstructing the concrete history of the issues, aspects and possible solutions in order to develop a deeper understanding of them; and, with the help of this understanding and the stimulated creative capabilities, on developing a new production process, product or market. The related First Order Concept is research and development for new processes and products. Researching and developing new markets was in two projects also part of the working out of new concepts.

In every project, activities could be distinguished that focused on collecting new knowledge or equipment, and on testing these to see if they would contribute to the desired results. I rank these activities under the concept of collecting and testing new knowledge or equipment.

As soon as research, development and testing had delivered satisfying results, the product of the innovation process was designed in its final form and the implementation or production was planned and executed. The related concept is designing and planning the innovations. Three of the four projects resulted in building, producing and implementing the innovations.

Studying the First Order Concepts, I distinguish three different themes. First, there is the theme where a problem is observed, the idea generation of the actors is stimulated, and where more or less vague images and concepts of the situation and possible directions of solution are developed. This theme I call Problem and Concept Development.

The second theme consists of activities that are meant to study more deeply the identified problem situation and possible solutions. The theme here is to improve understanding of the various aspects and to make sure that this understanding is common to the involved actors, and to choose a promising direction of development that is then tested. This theme I call Research and Testing.

The third theme is concerned with putting all findings from the previous phases together and designing, planning and implementing the actual solution and its realization process, taking into account the conditions that may promote or hinder actual execution. I call this theme Design and Implementation.

Together, the Second Order Themes form an Aggregate Aspect that represents the development of the different innovation processes over time, and that I call Innovation Processes Development (figure 7.2).

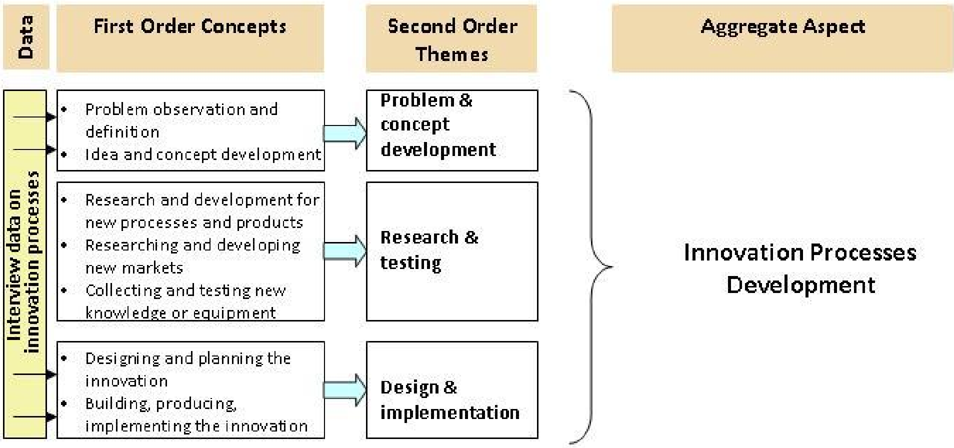


Figure 7.2 Innovation Processes Development

This Aggregate Aspect is important because in a process of social construction it represents the empirical, developing expression of the combined implicit and explicit knowledge, ideas and experiences of the actors in relation to the issues.

Table 7.1 Examples (Innovation Processes Development)

Innovation Processes Development	
Second Order Themes	**First Order Concepts and examples**
Problem & Concept Development *(An issue is observed, the idea generation of the actors is stimulated, and more or less vague images of the situation and possible directions of solution are developed)*	**Problem observation and definition** *"We can only survive in the bulk business if we continue to improve. That is a MUST. And we have to continue growing by producing more tonnes per head, because wages continue to rise and we have to be able to keep up with that. Unless wage levels were the same the world over, but that's not the case of course, so we have to be able to compete with countries with lower wage levels, the Czechs, Russians, and so on, not to mention the Chinese." (Technical Director of Company A)* *A point had been reached when I had to say: the number of ruptures has gotten so high that under current working practices we are unable to allocate enough people to deal with the problem. A rupture on a paper machine is very often a multi-layered one with, if you're lucky, a single cause but if you're unlucky 10 different and simultaneous causes. (...) The number of ruptures we had to deal with remained far too high." (Production Manager, Company C)* **Idea and concept development** *"So another path that we are following simultaneously is that of looking for alternative products for the paper machine. We've also considered taking the machine out of the production process, or moving it to Poland, we considered every possible option, but not one of them seemed satisfactory. We need to maintain present volumes in order to be able to cover our costs. Relocating the machine was not an option because it was still more economical to keep it in operation here despite the low profit returns. If we want to improve that situation, however, then we need to find alternative products for that machine. (…) We have set out two pathways of innovation for that machine, in the Agri-business. (...) and a third, geared towards the machine itself, not dictated by market demands, but based simply on the idea: look, we have the machine, what else can we do with it? We discussed this with a lot of people from the business and eventually ran some tests that led to the manufacture of a new product, paper strengthened with synthetic fibers. " (General Director, Company B)*

	"And then the Strategic Projects Manager, he came up with a very good comparison of the possibilities and the risks." (Quality Manager, Company C)
Researching & Testing *(Meant to study more deeply the identified problem situation and possible solutions to improve understanding of the various aspects, and to make sure that this understanding is common to the involved actors)*	**Research and development for new processes and products** *"I have also done the following. The pellet machines were not something completely new. But to make pellets from wood and plastic or from paper and plastic, that was a new venture. I came across a firm that makes wooden pellets for the plastic and other industries. They were based in Southern Germany. So I went there. Asked them: how can I make these pellets. The owner / director was 84 years old. At three o'clock in the afternoon at his kitchen table he said to me – you seem like a decent bloke so I'll tell you how to do it. You have to adjust the compactness of the pellet to the length – diameter ratio of the opening. That is actually very simple, but it's not if you don't know that. If you have a mixture of plastic and wood then you have to have a certain diameter – length ratio so that the plastic can melt and gel in such a way that it forms a hard pellet. Melting occurs under pressure from the wheel that turns in the matrix of the pelleting machine. Too much pressure and the plastic melts into a puddle that cannot be fed through the opening anymore. Too little and you get no pellet at all.* *I had the feeling that there was something I just did not know and that I simply had to find someone who could tell me because I would run into big trouble in trying to make pellets. All the other pellets were not the kind that we required, as regards hardness etc. We had to be able to control the process. The presses worked all right, but the question was whether or not the pellet was good enough for burning. If the burner needed a softer / harder pellet, how could we go about doing that?* *The man who told me all this milled wood from all over the world that he mixed with bakelite/plastic for telephones, to achieve a much harder material. The making of composites. He knew exactly what a cylinder blade did, and a hammermill, and a pelletizer. He did the work with high quality equipment. He made, for example, 3mm pellets. That was extremely interesting! His expertise was a matter of course to him, but for us it was crucial. Later on we could see immediately how to play around with the openings in the matrix etc., that made life an awful lot simpler." (Technical Director, Company A)* *"I looked up the IPPC,* [Integrated Pollution Prevention and Control (IPPC)-guideline] *and found an excellent BREF Paper* [Best Available Technology Reference documents] *that*

outlined the best available technology. The range for the NOx emissions was given as between 20 and 45 grams per gigajoule, if I remember correctly, and in Company C's proposal for the old machine that lay in the region of 70 to 80 grams per gigajoule. That was unacceptable to us and my manager at the time went hopping mad because he had conducted the negotiations on behalf of the Province in the period between 1999 and 2002 and back then Company C had agreed that when it came to their next investment in the machine that they would definitely invest in achieving compliance with the BEES [the decree on emission limits for combustion plants]. *They were referring, however, to the old version of the BEES, but they were installing a new machine and they thought that they could put it into production based on this older version. We wouldn't agree to that. I wasn't aware of this previous history when the company was first added to my portfolio."(The Licensing Authority of the Province of North-Holland, in relation to Company C)*

Researching and developing new markets

"My most important task is to link our contacts in the market with the opportunities that are open to us. We are now on the cusp of a project in which we have a product ready - one that still requires some development - that offers us a lot of possibilities, and we have to make sure that the market can fulfill its potential for us. This will require a number of brainstorming sessions. We have identified a development in the market where there is a growing preference for simple products over more traditional types of cleaning cloths. That opens up a whole new world of possibilities and it is up to me to get the players in the market to come to the table." (Sales, Company B)

"Who went to the meetings with [the potential customer]? [Recycling Manager of DSM] *and me. We have always taken the lead in the first instance. The first meetings were mostly at the director level. Subsequent meetings were usually left to other managers.' (The Engineer environmental research of DSM, related to Company A)*

Collecting and testing new knowledge and equipment

"I spent hours discussing how to tackle problems regarding domains of responsibility with the contractors, with all kinds of examples. They knew that I would come back to them on that." (General Director, Company C)

"We started with a small group of people, the Production Manager, the Director Operations and The General Director, I believe, and the head of process technology at the time. They researched what kind of synthetic fibers there were to be had from several different suppliers." Process Technician,

	Company B) **Designing and planning the innovation** *"After that phase I was asked to take charge of the strategic projects, to review the bottlenecks and the limits. In other words: I had a lot of influence, especially at the preparatory stage." (Manager Strategic Projects, Company C)* *"But we wouldn't have managed to do any of this if Miklas had not been involved, because you need somebody who can make firm decisions. Miklas could say: let's shut down the machine and carry out the necessary adjustments. It was also important that Miklas understood the total picture and wasn't just preoccupied with the day's production tonnage. He also looked at things like: what do I want the situation to be like a week or a month from now. He recognizes the need to invest time and money in order to produce results; he is more entrepreneurial." (Process Technician 2, Company C)*
Design & Implementation *(The production and implementation are planned, including the circumstances that may promote or hinder actual execution)*	**Building, producing and implementing the innovation** *"I was completely in charge of construction, which I delegated out to The Head Engineer and the personnel from Stramproy [SPS - HvK]. I carried the can. But it involved simple techniques: foundation, cement work, build a house, put things in it. Not at all complicated to us, bread and butter stuff. With the full powers of a project leader, it wasn't going to matter what color you might paint the walls at the end as long as you stayed within budget." (Technical Director, Company A)* *"There is always going to be a kind of fatigue curve, which is never linear, but that rises exponentially as time goes on. If you haven't agreed on how to deal with domain issues in advance, then that will eventually get the better of you in the fatigue. People are then no longer inclined to think that the fault may actually lie with them. Everybody just turns a blind eye to everything. In that last phase you almost need a team of psychologists to help people to see the common interest and get the project done. You can see it coming, that people are getting tired out and stop talking to each other, and limit communication to e-mails. Communicating through e-mail is the biggest problem." (General Director, Company C)*

7.3 The actors, teams or networks

Interviewees talk about the different actors that were involved, and their different policies, goals, expertise and cultures. They report activities that were undertaken to involve these actors and to set up organizational arrangements to meet and to cooperate in the execution of the innovation processes. Interviewees also report policies and contracts that played a role in realizing the projects. From the interviews I could distil ten different First Order Concepts related to actors, teams or networks and to the structures that facilitated their interaction. Examples of the First Order Concepts from the four projects and their relation to the Second Order Themes are given in Table 7.2.

In each of the four projects, actors from economic, ecological and/or social networks could be differentiated. In one project, the diversity in networks among the actors was high (Rofire project), while in another it was low (TFR project). Managers engaged in networking and actor involvement activities in order to introduce actors with new knowledge and experience into the project.

Guiding the projects, managers formed new teams or reformed existing teams to match them to the requirements of the innovation processes (Teams (re)formation). Managers also developed new, formal meeting structures in order to facilitate communication and cooperation among the involved actors (Meeting development). New innovation policies, strategies or management approaches were developed to deal with company and/or societal issues, to approve and support the innovation processes, and to structure the necessary cooperation and communication. Organizational structures at the paper and board producing companies were adapted or improved to facilitate the projects (Company organizational structures). Company policies were designed to define the projects and the cooperation with other actors. Formal contracts served to define and manage the contributions of actors to the projects. Different sorts of formal groups, teams or committees, together with different kinds of informal meetings and work consultations, were used to prepare, coordinate and execute innovation activities.

Second Order Themes can be distilled after characterizing the different First Order Concepts. First, I identify concepts that are related to the actual functioning teams or groups in which the actors work together and execute the innovation processes. I call this theme Informal Meetings and Formal Structures, and it includes contracts, informal meetings on the shop floor, teams and steering groups.

The second theme that I discern I call Issue Related Involved Actors. This theme comprises the different actors that were related to the issue and were involved. The theme includes aspects like their policies, goals, expertise and cultures, in relation to the (economic, ecological or social) networks that they originate from.

The third theme that is revealed consists of the processes that were used by actors to organize or improve their cooperation: Actor Involvement and

Structure Development. This theme is about processes of networking and the involvement of actors, the formation of teams, the development of meetings and new policies, strategies or management structures.

Studying what is reported about organizational structures in the interviews, I find that the three Second Order Themes (see figure 7.3) are ranked under the Aggregate Aspect of Inter-Organizational Learning System Development. This Aggregate Aspect is important because it represents the structural platforms and the dynamics that enable actors to meet, discuss, argue and recombine ideas and knowledge and thus give form to the innovation processes and their development.

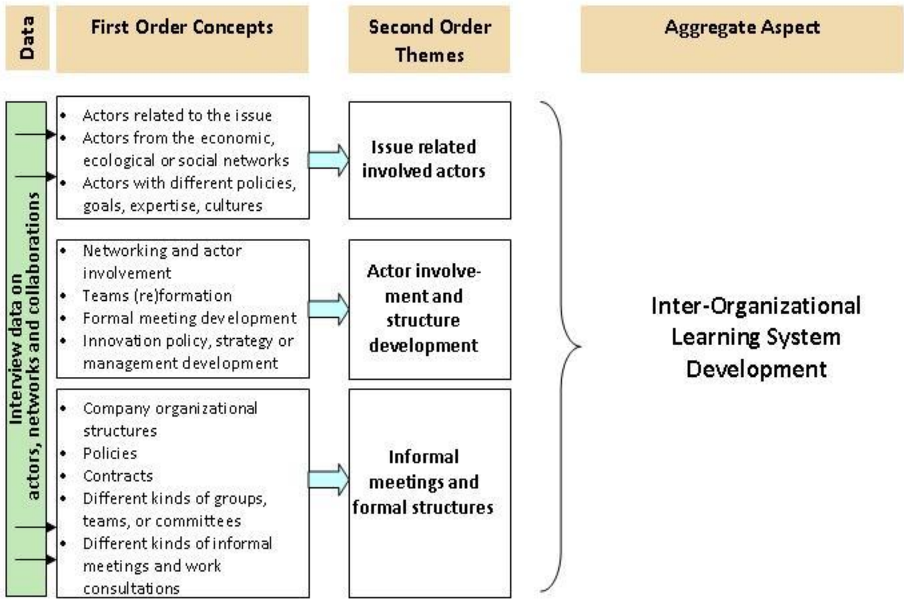


Figure 7.3 Inter-Organizational Learning System Development

Table 7.2 Examples (Inter-Organizational Learning System Development)

Inter-Organizational Learning System Development	
Second Order Themes	**First Order Concepts and examples**
Issue related involved actors *(The different actors that are involved, including aspects like their policies, goals, expertise, cultures, related to the (economic, ecological or social) networks that they originate from)*	**Actors from the economic, ecological or social networks** *"The Technical Director was busy behind the scenes with the local authorities and it was his plan. He lobbied The Deputy of Environmental Affairs of the Province of Limburg around that time." (The Head of the Department Quality and Process of ENCI, related to Company A)* *"There was also a whole conglomerate of small companies involved. I had to look after these so that the principal contractor could get on with his job." (Manager Strategic Projects, Company C)*
Actor involvement and structure development *(The processes that were used by actors to organize or improve their cooperation, processes of networking and the involvement of actors, the formation of teams, the development of meetings and new policies, strategies or management structures)*	**Networking and actor involvement** *"The General Director and I went to the non-woven trade fair and established some contacts. I took it over operationally then, but he kept a close eye on it all. (...) We met and talked to people who had worked in this sector and who had previously tried it out. We talked to consultancy agencies, went to the trade fairs and eventually established links with various parties with whom we carried out some laboratory tests." (Director Operations, Company B)* *"I was constantly in touch with Production and checked the results. I increased their knowledge of the process itself, of what they were actually doing and made them aware of the importance of consistency." (Process Technician 1, Company C)* **Teams (re)formation** *"In order to have the permissions granted smoothly, ENCI and* Company A *had a direct contact with the County Deputy of Environmental Affairs. The three of us formed a team and the permission was granted on time." "I searched out some of the people for the steering group. Starting with the project steering group, which not everybody wanted to be a part of." (Technical Director, Company A)*

	"We decided, only last month actually, to implement some further measures, and to commit to working with innovation teams, in the same way as we work in Production with improvement teams. Innovation teams that report to a sounding board group, so that we can up the level of activity." (Director Operations, Company B) **Formal meeting development** *"Conflicts would arise now and again concerning things that would just not get together and we handled that. I used one of Jacobs' methods for planning for that in order to get all the stakeholders together and to conduct an active planning session, so that every stakeholder would know what was being agreed on. The project leaders also contributed in a similar way." (Project Manager 1, Company C)* *"It was Miklas who decided on the structure of the TFR." (Process Technician 2, Company C)* *"My principal role was in maintaining the discipline that enabled us to meet every day, but also in having the drive to persist in asking, when there'd been another rupture, well, what are we going do about it?" (Company Manager, Company C)* **Innovation policy, strategy or management development** *"The innovative part of this project is the different way of looking at waste. We saw it as a product instead of as waste. For me this way of looking at things is normal. This project was all about changing a mindset: we are not paper producers, we are recyclers of used paper, if necessary into various products! So we can make money out of all elements of used paper. (There is 50 tons of aluminum in used paper!) This kind of thinking was actually not done in the sector. But now we select the input into different streams and sell them." (Technical Director, Company A)* *"Innovation as a process is completely new to us. My colleague, the director of operations, took a course on innovation last year at the Vlerick School of Management at the University of Leuven, which he completed with a paper on innovation. That provided us with some theoretical background and we are currently applying that to the innovation process within the company. It's early days yet, however.(...) "In the past I have made the mistake of thinking: innovation is not for us because we're no Kimberly-Clark and we simply cannot afford to take a machine out of the production process for any length of time. In retrospect we were mistaken in thinking this way, because I am now convinced that we, as a small company, are in an even more advantageous position when it comes to being innovative."*

	(General Director, Company B)
Informal meetings and formal structures *(The actual functioning teams or groups in which the actors work together and execute the innovation processes)*	**Company organizational structures** The Morning Meeting (TFR-project, Company C) The Company C management and ownership structure; the Workers Council; the regular Projects Meeting (DLE-project, Company C) **Policies** *"In a production environment it is a nuisance to start doing something new. Things can go wrong, and this endangers the company. So think well and run only calculated risks. These risks differ between companies." "We brought a new product onto the market, which was a risk. So I did not want additional risks in the production processes. They would have to consist of proven technologies and elements, so we would have a clear and limited risk." (Technical Director, Company A)* "[The Company Manager] *played a crucial role in the decision-making. He pointed out where the priorities lay, he constantly asked us what we were planning to do next and how we were going to do it and when it would be finished." (Process Technician 1, Company C)* **Contracts** *"That's when the suppliers come on board. They are involved in the discussions about fibers and how we could expect them to behave during the process. The suppliers we chose were Hercules form England and FiberVisions from Denmark. But we also met with Voight (machinery suppliers) and analyzed non-wovens with Mill Vision." (Director Operations, Company B)* *"We also brought in some contract managers to support the project leaders in the project. That wasn't taken seriously enough here. When you sign a contract worth a couple of million then you need a contract manager to manage the agreements, the progress and contract variations and the value of that is underestimated here. (…) When you sign a contract with a supplier for engineering, development work, delivery, installation, you can't expect all that to just fall into place by itself. I put a lot of effort into getting the supplier to supply us with information." (Project Manager 1, Company C)*

	Different kinds of groups, teams, or committees Subcoal; Steering Committee; Consultations in Company A, RPE and with Division management; Permission acquisition team (informal); Meeting with neighbors; Project Steering Committee; Project Building Team; three specialized implementation teams (building, mechanics, electrical systems) (Company A) Four Project Workgroups; Safety Meetings; the Project Buying Team (DLE-project, Company C) **Different kinds of informal meetings and work consultations** *"Once I came back to my office to find two operators sitting there with someone from (...) the world of dog-breeding. We had no idea if anything would ever come out of it, but we did immediately form a team out of that small grouping. And now our website offers people the possibility of becoming a sales rep in paper towels for dogs for our company. You see, we simply make use of the existing momentum. I'm convinced that kind of thing is contagious." (Director Operations, Company B)* Informal meetings e.g. on the work floor, in the corridors of the offices and in coffee corners (TFR-project, Company C)

7.4 The managerial capabilities

Interviewees gave an impression of the capabilities they applied in the projects. Most interviewees were also able to tell how they developed these capabilities and what the major factors of influence were. Examples of the First Order Concepts from the four projects and their relation to the Second Order Themes are given in Table 7.3.

In the projects, the managers and specialists applied diverse capabilities, e.g. for research, networking, communicating, management, stress and project management, coaching, organizing, teamwork, visualization, and relating theory to practice. In addition to these capabilities, managers also applied diverse methods, e.g. methods to manage, to do research, to solve problems, to communicate or to deal with technological issues. And lastly, diverse philosophies ('philosophy' in the sense of *"A set or system of ideas, opinions, beliefs, or principles of behaviour based on an overall understanding of existence and the universe; a philosophical system or theory; a view, an outlook"*, Shorter Oxford English Dictionary, 2002*)* were applied by the managers, e.g. in the fields of innovation and development, management and project management, learning and organizational development, teamwork, sustainability or quality improvement.

When asked about the development of their applied capabilities (including methods and philosophies), interviewees often refer to their nature and character, inherited from their parents, as a an influential factor. They also mention family and regional culture, and the culture and work methods of the company where they work. Interviewees report that they developed their capabilities through work experience in other projects, functions, countries or companies. Also, formal education programs contributed to the development of their capabilities.

Studying the First Order Concepts and the interviews, the following Second Order Themes regarding managerial capability development can be distilled.

First, I identified the different managerial capabilities that interviewees applied and that are the outcome of their professional and personal development histories. The capabilities, methods and philosophies relate not only to the innovation processes but also to the development of the learning systems that facilitate these processes. Therefore, I call this theme Capabilities for Innovating and Learning System Development.

The second theme that I have distinguished from the First Order Concepts consists of the diverse factors that have influenced the personal and professional development processes of the managers I interviewed. This theme I call Factors Influencing Capability Development.

The third theme comprises the actual development processes in which the capabilities were given form. The two processes that were reported are formal education and work experience. This theme is called Capability Development Processes.

Together, the Second Order Themes represent different aspects of the development of capabilities for learning and innovation, and therefore they rank under the Aggregate Aspect of Innovation and Learning Capabilities Development (figure 7.4). This Aggregate Aspect is important because managerial capabilities, methods and philosophies are at the basis of the qualitative characteristics of innovation processes and learning systems. They thereby exert great influence on the outcomes of projects.

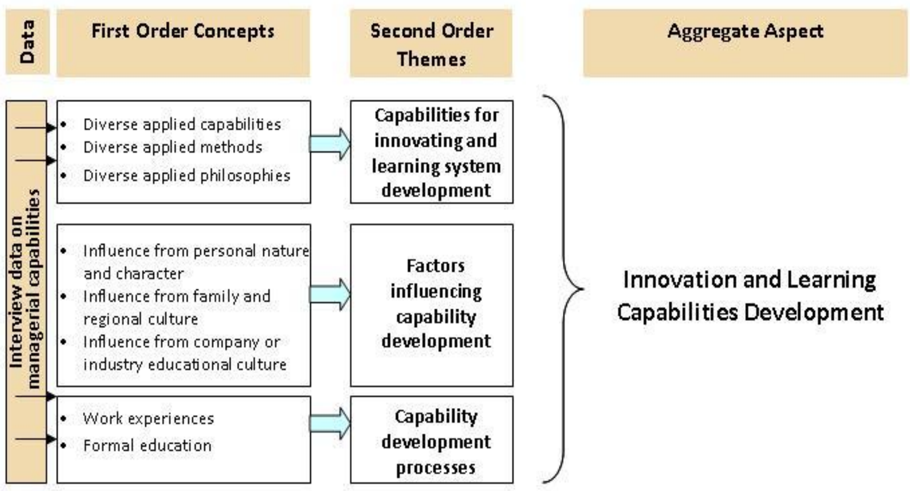


Figure 7.4 Innovation and Learning Capabilities Development

Table 7.3 Examples (Innovation and Learning Capabilities Development)

Innovation and Learning Capabilities Development	
Second Order Themes	**First Order Concepts and examples**
Capabilities for innovating and learning system development *(The different managerial capabilities that interviewees applied and that are the outcome of their professional and personal development histories)*	**Diverse applied capabilities** *"An architect is able to play out all the possible scenarios in his head. So, I can see that building in my head, I've been there, I know exactly what it's like, I also know the factory inside out, so if somebody tries to claim this, that or the other, I say bullshit, go and see for yourself. Because I have it all here in my head. Not many people have that. Some, but not many. Few people have a complete overview of the factory." (Technical Director, Company A)* *"A stimulating and encouraging role, as opposed to a very involved one. That was my contribution". (…) "That I was able to explain to the people in the frontline, especially those in Sales, what we were up to and the possibilities it presented, and to show them examples of the kind of innovative project we were engaged in, and that we were well capable of being innovative." (General Director, Company B)* *"Analytical skills, it is, after all, simply a matter of analysis, that's the starting point for so many things: the facts first. (…) And combining the things that you've learned from experience. A lot*

	gets started that way." (Company Manager, Company C) *"And André Duiker is very thorough. But he has less of an eye for the process as a whole, recruiting people and keeping them up to speed, ensuring that all agreements are met in full. But you need them both. André is solid as a rock when it comes to the rapid evaluation of proposals and double-checking everything." (Company Manager, Company C)* **Diverse applied methods** *"You make people happy by helping them in advance and by making decisions that make it easier for them to get on with what they are doing, because it is their own idea and they are part of the puzzle. They will simply stop performing if you don't pay attention to them. It is a way of exercising power, but then in a socially interactive way." (Company Manager, Company C)* *"I have 120 people working in Production and they are all different. You just have to weigh it up: this one needs to be handled like this and another completely differently. With the specialists, in particular, you have to be careful to respect another's opinion but also be able to lay down challenges. Some of them need to be reined in more than others from time to time." (Production Manager, Company C)* *A couple of years ago we carried out a survey here on the level of satisfaction among employees and the results of that led to some improvements. It concentrated on communication and information and I was able to apply the experience I gained at Unilever in the form of cascade meetings." (Director Operations, Company B)* *"If I don't trust something inherently I'll examine it thoroughly. (…) If something is to be decided on at the technical level then I want to know how it will function." (Technical Director, Company A)* **Diverse applied philosophies** *"So I've got the environment issue to deal with, which could always be sold on the premise of, if you don't want to do it for environmental reasons, then do it for your own wallet. Try to employ energy and water saving methods, use resources efficiently and of course, with this commitment and if you are making new investments, don't forget to look for the best on offer, if attainable and affordable, also when it comes to the environment." (The Deputy of Environmental Affairs of the Province of Limburg, in relation to the Rofire project of Company A)* *"(…) It is a learning process. You have to try and involve as many people as possible and gather as much knowledge, skill and input as you can, and you have to make certain choices and pursue a particular path. I think we have managed to do that and, as a*

	result, have been able to achieve the desired end result quite quickly. Some things always go wrong of course, but that is to be expected." (Production Manager, Company B) *"To me, the ultimate objective is to get the maximum tonnage possible out of the factory. You can have the very best machines, but they are of no use if they are not producing any paper. It's all about combining man and machine. The machines seem to be working well now, so the next thing is: how can we better develop our people? That keeps me busy day and night." (Production Manager, Company C)* *"When you say no to a person's idea you end up losing the confidence of that individual. We're very good here at saying no to people. Even though the initial idea may not have been great you still should try to motivate the person to develop it. You can learn so much from saying yes to people, they tend then to open up to you. A little exercise like this can benefit a company tremendously. We did this as part of Works council project and the result was a completely different kind of team, because literally everything is open for discussion." (Process technician 1, Company C)*
Factors influencing capability development *(The diverse factors that have influenced the personal and professional development processes of the interviewed managers)*	**Influence from personal nature and character** *"My first jobs were more technology oriented, but it wasn't long before people wanted me involved in Sales, wanted to take me along to see clients, so one way or the other I must have had the ability to stir up people's enthusiasm, I just wasn't really aware of it myself. I hated Sales actually, I just wanted to concentrate on the technical aspects, but all the while I was being pushed, literally begged, to go talk to clients." "I suppose it's just part of my make-up (…)."And you have to enjoy it too, of course. I enjoy doing presentations and readings, and it helps that others enjoy what I do. That has a reinforcing effect." (General Director, Company B)* *"That's always been part of who I am, it's not something that I developed over time. But it's difficult to explain. All my life I've been analyzing people and philosophizing. From before I can remember. When I go on holidays, for example, my first instinct is to submerge myself in philosophy, real deep stuff like the philosophy of science, I've always been like that." (Process Technician 2, Company C)*

	Influence from family and regional culture *"I did Gymnasium Beta, but I didn't get my diploma because I had to repeat 5th year and I wasn't interested in doing that. My brothers and brother-in-law were in the navy, pretty 'sea-minded' if you like. I didn't want to join the navy, but rather the merchant navy. And technology is in my nature, so …. I thought, well why not, if you complete two or three courses…... I went to the Maritime Academy in Vlissingen, where you could study to be a helmsman, radio operator or engineer." (The Engineer environmental research of DSM, related to Company A)* *"My father was very technically-oriented. I inherited that from him and I was always interested in how certain things worked. My father had an electro technical background and was head of sales at a car dealership. He was good at keeping in touch with events on the work floor. He also enjoyed talking to the mechanics. And he was a terrific salesman." (Production Manager, Company B)* **Influence from company or industry educational culture** *"The Keppner Tregoe course helped enormously, but then again everybody took the course. The top brass even went and did follow-up courses. If we have a rupture that we cannot figure out, then we go and get someone from outside the task force who can analyze and tackle the problem. With Keppner Tregoe everybody thinks and reasons the same as everybody else. The thing about Keppner Tregoe is that it helps you to define and analyze a problem in a structured manner. We still make use of it to this day." (Production Engineer, Company C)* *"The head of the Technological Department at Company C and the subsequent director also taught me an awful lot. The management's method of coaching makes a big difference." (Company Manager, Company C)*
Capability development processes *(The actual development processes in which the capabilities were given form)*	**Work experiences** *"Specific skills, well, I mean, when you've been designing and building new plants for 30 years, that tends to work almost automatically after a while. (…) Eventually that simply seems quite normal." (The Head Engineer, Company A)* *"I'm chairperson of the Works Council. I've learned a lot from carrying out that function, things that make you a lot more self-assured. More critical and better able to pose the right questions." (Process Technician 1, Company C)*

	Formal education *"I also concentrated heavily on communication during my studies in Nijenrode… that was a very formative period for me. I studied there for one year and learned so much about communication, all the dos and don'ts." (General Director, Company B)* *"I have had a higher education in electro-technology and measuring and control technology." (Project Manager 1, Company C)*

7.5 Concluding remarks. Overview of the Aggregate Aspects

In the analysis of the interview data, I have constructed three main Aggregate Aspects for the innovation projects that each contain First Order Concepts and Second Order Themes: Innovation Processes Development, Inter-Organizational Learning Systems Development and Innovation and Learning Capabilities Development. These three aspects are important because they cover the developments that are demonstrated by the First and Second Order Themes, grouped within three main themes of the innovation projects (innovation processes; managerial capabilities; actors, networks and collaborations). The contents of all Concepts, Themes and Aspects are firmly rooted in the thick descriptions of the projects and the narratives of the interviewees. To demonstrate this connection, tables with quotes were included above. An overview of the Aspects and Themes is presented in figure 7.5.
I conclude that the Aggregate Aspects and First Order Concepts and Second Order Themes do not yet provide sufficient insight into the qualitative characteristics of the processes of innovation, the learning system and capability development to answer the research questions and model the main factors and dynamics of inter-organizational learning for innovation. In order to arrive at such an insight, in chapter 8 qualitative cross-case analyses are performed, structured along the themes and aspects developed in chapter 7. In chapter 9, the analysis and cross-case analyses are combined to provide answers to the research questions and construct a conceptual development model of the dynamics of inter-organizational learning for innovation. The cross-case analyses, the answers to the research questions and the model form the basis for the conclusions and recommendations in chapter 10.

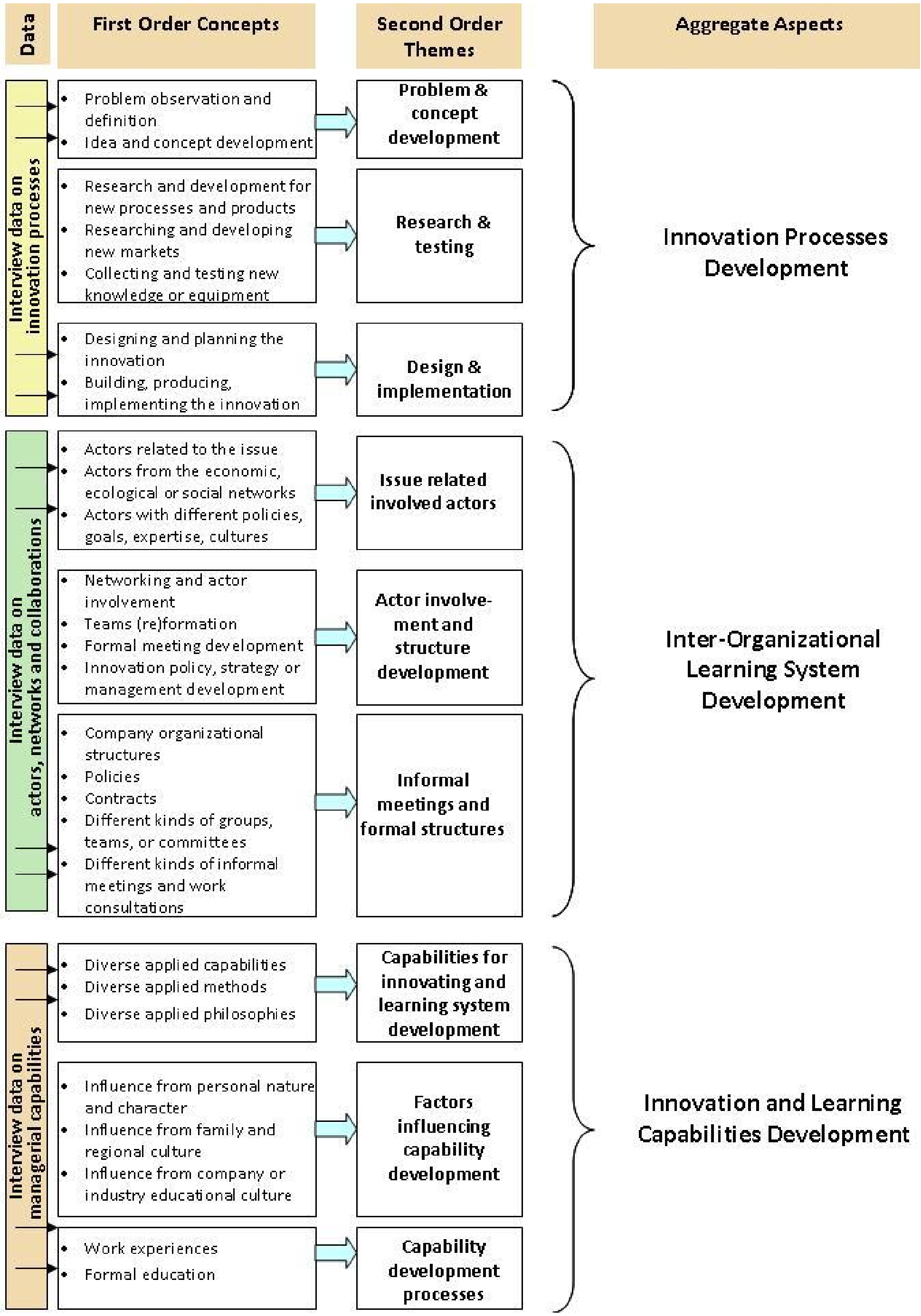


Figure 7.5 Overview of the First Order Concepts, Second Order Themes and Aggregate Aspects

8 Cross-case analyses

8.1 Introduction

In chapter 7, I analyzed the interview data and structured it into First and Second Order Themes and three Aggregate Aspects. However, this analysis has only generated categories without qualitative characteristics and without any specification of interrelationships and dynamics. In order to create deeper insight into the factors and processes that underlie the development of the projects and their differences, cross-case analyses are needed.

In this chapter, I present cross-case analyses structured along the three Aggregate Aspects of the innovation projects: the Innovation Processes Development, the Inter-Organizational Learning System Development and the Innovation and Learning Capabilities Development. Thus, insight is developed into the differences between the innovation projects that are focused on economic issues alone and those that are focused on both economic and environmental issues. The applied managerial capabilities and their developmental factors are clarified. Their relation with learning and management satisfaction is analyzed and the basis is laid for the development in chapter 9 of a conceptual model of the dynamics of inter-organizational learning for innovation in the four projects.

I first present an overview of the outcomes and learning processes of the projects (8.2) and of the structure of the cross-case analyses and the project data (8.3). I then analyze characteristics that are common to all projects (8.4). Next, I compare the projects in which management satisfaction was low (TFR) with those in which satisfaction was high (DLE, Rofire, Wetlaid) (8.5). And, in 8.6, I compare the projects that focus on economic issues (Wetlaid, TFR) with those that focus on economic and environmental issues (Rofire, DLE). In 8.7, I specify the developmental phases in each Aggregate Aspect, and in 8.8, I analyze how the Aggregate Aspects influenced each other. In 8.9, I study the factors that have stimulated inter-organizational learning in the projects. I finish with concluding remarks in 8.10.

8.2 Structure of the cross-case analyses. Project data.

The cross-case analyses are based on the matrix structure as shown in figure 8.1. In the cells in rows 1-4 and the columns A-E, the characteristics of the projects and their Aggregate Aspects are presented. The projects that focused on economic and environmental issues are colored dark blue. The projects that focused solely on economic issues are colored light blue.

Column A indicates the degree of management satisfaction with the outcomes of the projects. As indicated above in 8.2, based on these satisfaction levels, the DLE, Rofire and Wetlaid projects were the most successful and the TFR-project the least successful of the projects.

Column B shows the degree of learning that has been accomplished, measured according to the number of networks that were involved in creative and learning processes, as indicated above in 8.2. In the Rofire and Wetlaid projects, actors from all involved networks realized learning.

			Aggregate Aspect				
	A. Satisfaction with company management	B. Learning by...	C. Innovation Processes Development	D. Inter-organizational Learning Systems Development	E. Innovation and Learning Capabilities Development	F. The dynamics between the Aggregate Aspects	G. Factors that stimulated inter-organizational learning
1. DLE	High	Actors from the economic network				section 8.8	section 8.9
2. Rofire	High	Actors from all involved networks					
3. Wetlaid	High	Actors from all involved networks					
4. Task Force Ruptures	Low	Some actors in the economic network					
5. Common characteristics of the projects			section 8.4				
6. The factors that stimulated management satisfaction			section 8.5				
7. The characteristics of the projects focused on economic and environmental issues in comparison with those of projects focused only on economic issues			section 8.6				
8. The developments within the Aggregate Aspects			section 8.7				

Figure 8.1 Outline of the matrix used to compare the innovation projects with each other

In the DLE project, the actor from the ecological network (the Provincial Government) enforced regulation and was not involved in creative and learning activities. In the TFR project, only some actors from the economic network participated fully in creativity and learning. The columns C, D and E of rows 1 – 4 are reserved for the main data of each Aggregate Aspect of each project. Their contents are presented in table 8.1.

In rows 5 - 8 and columns F and G, the outcomes of the cross-case comparisons are presented. Due to the limited space, in each section only the relevant rows and columns of the matrix are shown. The data in table 8.1 forms the basis for the cross-case comparisons in the sections 8.4 – 8.9.

Table 8.1 The Aggregate Aspects of the innovation projects

	Aggregate Aspect		
	C. Innovation Processes Development	**D. Inter-organizational Learning Systems Development**	**E. Innovation and Learning Capabilities Development**
1. DLE	– Economic and environmental issues – Development from Problem & concept development to Research & testing and Design & Implementation – Reconstruction of issues and their multiple aspects – the idea to combine improvement projects was developed in discussions between company managers and a supplier – Management contributions mainly to (Inter) Organizational Learning System Development – Management involvement in all Second Order Themes	– Diverse and complex inter-organizational learning system; ecological, social and economic networks involved; internal and external actors – Broad process of social construction with all networks – The main decision to invest was enforced by one actor from the ecological network – Conflicts and frictions stimulated more focused problem and concept definition, deeper research and the development of alternative solutions – Managers developed regular, existing (inter) organizational innovation structures, complemented with new and temporary ones – Gradual development of inter-organizational learning system	– Applied capabilities to promote learning and understanding on a team level, and complementary philosophy, capabilities and methods for communication and organisational Development – A sustainability philosophy with the actor from the ecological network – 4 senior managers participated – Innovation philosophy: innovate by finding new combinations, not only through large projects but also by incremental improvements – Management initially not needed new knowledge and skills, and did not engage in networking – Focus: keep the communication going to prevent escalation of differences of opinion and tensions – (Stress and project) management by (1) managing organisational, project and meeting structures, (2) showing leadership and insight, (3) being available and interested – Communication characterized by (1) being approachable; (2) consulting with people and informing them as completely as possible – Dynamic capability development process

	Aggregate Aspect		
	C. Innovation Processes Development	**D. Inter-organizational Learning Systems Development**	**E. Innovation and Learning Capabilities Development**
2. Rofire	– Economic and environmental issues – Development from Problem & concept development to Research & testing and Design & implementation – Reconstruction of issues and their multiple aspects – The new idea was developed simultaneously by other actors. It became a new option in interaction with internal and external actors who complemented each other – Management contributions: mainly to innovation processes development – Management contributions to all Second Order Themes	– Diverse and complex inter-organizational learning system; ecological, social and economic networks involved ; internal and external actors – Broad process of social construction with all networks – Joint decision-making on the basis of common understanding of the issues and project – Disagreements stimulated more focused problem and concept definition, deeper research, alternative solutions and improved execution – Managers developed further regular, existing (inter)organizational innovation structures, complemented with new and temporary ones – Gradual development of inter-organizational learning system	– Managers applied capabilities to do research and to understand the technical sides of the issues – A sustainability philosophy with actors from all kinds of networks – 3 senior managers participated – Innovation philosophy: try to continuously and incrementally improve the efficiency of the production process and reduce environmental impacts by finding new combinations – New knowledge and skills needed. Managers engaged in networking and involving external actors – Actors tried to prevent escalation of differences of opinion by applying a balanced way of holding people responsible and focusing on common interests, partnerships and alternative solutions – Dynamic capability development process

	Aggregate Aspect		
	C. Innovation Processes Development	**D. Inter-organizational Learning Systems Development**	**E. Innovation and Learning Capabilities Development**
3. Wetlaid	– Economic issues – Development from Problem & concept development to Re-search & testing and Design & implementation – Reconstruction of issues and their economic aspects – the discovery of Wetlaid took place in a process of searching, researching and testing by different actors from inside and outside the company – Management contributions mainly to (Inter) Organizational Learning System Development – Management involvement in all Second Order Themes	– Diverse inter-organizational learning system, social and economic networks were involved, internal and external actors – Broad process of social construction with these networks – Decisions regarding the innovation processes were taken by company management – Conflicts or competition were avoided or prevented – Managers developed regular, existing (inter) organizational innovation structures, complemented with new and temporary ones – Gradual development of inter-organizational learning system	– Applied capabilities: to understand mainly the technical issues – A new innovation and development philosophy was developed – A sustainability and innovation philosophy was not present – 2 senior managers involved – New knowledge and skills were needed; managers engaged in networking and involving external actors – Management tried to prevent frictions and competition by promoting common understanding about the issues and the project – Methods and capabilities to improve communication through better organizing and structuring – Dynamic capability development process

	Aggregate Aspect		
	C. Innovation Processes Development	**D. Inter-organizational Learning Systems Development**	**E. Innovation and Learning Capabilities Development**
4. Task Force Ruptures	– Economic issues – Development from Problem & concept development to Research & testing and Design & implementation – Reconstruction of issues and their technical aspects – Improvement options were discovered in meetings between managers and specialists from different departments – Management contributions: mainly to (inter) organizational learning system Development – Involved in Problem & Concept development and Research & Testing	– A simple organizational learning system, only the economic network was involved, only internal actors – Limited scope of the process of social construction – Decisions regarding the innovation processes were taken by company management – Conflicts stimulated more focused problem and concept definition and deeper research – Managers developed new and temporary organizational innovation structures that were stopped when the project finished – Gradual development of inter-organizational learning system –	– Applied capabilities to do research and understand mainly the technical issues – No sustainability philosophy – 1 senior manager was involved – Innovation philosophy: innovate by finding new combinations, not only through large projects but also by incremental improvements – Managers had no need for new knowledge and skills, and did not engage in networking – Focus: keep the communication between actors going to prevent escalation of differences of opinion – Managers see their role in organisational development as initiating and active in developing people – Management, stress and project management by methods and philosophies for activating people through (1) coaching, managing, challenging, motivating and stimulating people with enthusiasm; (2) walking around and (3) delegating responsibilities – Applied capability and philosophy to stimulate teamwork through creating an atmosphere – Dynamic capability development process

8.3 Learning processes and outcomes of the projects

The foci of the projects compared

To understand the innovation processes in the four projects, it is useful to recall the national and international economic and regulatory context in which the companies were operating, which I outlined in chapter 5. The main and constant themes that influencing the Dutch paper and board producing sector at the time were resource scarcity and dependency, the energy intensity of the production process and rising energy prices, various environmental issues, productivity and international competition. Although the nature of the four projects differed, these themes can all be recognized in their origins. In the TFR project, the innovation processes focused on the development of measures to improve productivity by improving the production process. In the DLE project, the innovation development processes had the goal of developing a new combination of projects to realize a facility, in reaction to environmental and cost issues. In the Rofire project, innovation processes focused on the development of a product and a production process that were new to the company, in reaction to an efficiency issue and a sustainable development issue. In the Wetlaid project, innovation processes were meant to address the issue of international competition by developing a new competency, starting from an existing production process.

The development processes in the projects were very similar and can be seen in the First Order Concepts, Second Order Themes and Aggregate Aspects developed in chapter 7. The innovations on the level of the products and processes attract the most attention, but innovation and development also took place in other fields.

The outcomes of the projects compared

The combined DLE projects have improved the energy efficiency of the company and have enabled the company to reduce the costs of personnel. The relationship with the Province has become less complicated and reporting requirements have decreased. Support from the Province for Company C has increased, and Company C has learned new ways of project management and of dealing with suppliers.

The Rofire project has generated a new production process and a commercially attractive new product. It has improved the efficiency of the company and it contributes to the reduction of CO_2 emissions. However, continuation of the results was endangered by the lack of involvement of

Company A employees in market development. Only after in-house knowledge and experience in market development had been built, could the results be called satisfactory.

The Wetlaid project has not resulted in a modified production process or a new product. It has, however, contributed to strengthening innovation potential through the improvement of innovation policy and tools and of multi-actor innovation structures. Thus, it has indirectly contributed to the later development of Cradle-to-Cradle certified toilet paper in a different project.

Through the TFR project, Company C has gained more insight into the various backgrounds of ruptures in the paper flow. New tools and measures have been devised to prevent and/or analyze ruptures. A new method has been devised for multidisciplinary analysis and idea generation. The number of ruptures decreased, more time became available for product development, and the organization has become much more alert to problems. However, the work methods and philosophy of the TFR were not integrated into company policy and work routines, and the TFR was eventually dissolved. The result was that the number of ruptures and their complexity began to rise again.

Comparing the outcomes of the TFR and DLE projects, I conclude that when measured according to management satisfaction, the DLE, Rofire and Wetlaid projects were the most successful and the TFR project the least successful of the projects.

Accomplished learning processes

With regard to the accomplished learning processes (Siebenhüner and Arnold, 2007, p.341) I conclude that in the Rofire, DLE and Wetlaid projects double-loop learning was realized.

In the Rofire project, there has been a reflection on the business processes and outcomes (e.g. regarding waste), and at least some of the company behaviors and dominating values and strategies (regarding recycling and the function of the company) have been changed. A learning process to develop new knowledge (e.g. regarding the market for Rofire pellets and the reduction of chloride in the pellets) has been started and continued. In the project, a radical innovation in waste management and policy has been developed. Because of the joint decision-making, learning has taken place with actors from all three (economic, social and ecological) networks involved.

In the DLE project, the changes had an incremental character. They were mainly on an operational level (e.g. the gas turbine, automation), but were also apparent in project and contract management processes. The company’s strategies regarding projects and suppliers were improved. The scale and complexity of the combined projects were a radical change from the past and the original plans. Despite the complex inter-organizational learning system, actual learning and innovation did take place, especially within the economic network, because the Provincial Authorities were not involved in the creative part of combining the various projects. Backed by legal power, they could stick to their original view.

In the Wetlaid project, management and employees have reflected on parts of the company production processes and their outcomes (PM3 and possible new products). The envisioned improvements on PM3 and the produced paper were incremental. In the process of reflecting and experimenting, a radical renewal of the company innovation philosophy and method has been realized.

In the TFR project, single loop learning was realized. The improvements that have been developed were related to the operations in the paper production process. The developed changes were incremental in character. Although the approach of the temporary task force meant a radical improvement, due to the temporary character of the task force and due to a lack of formalization in policies and work methods, existing regulation systems, work methods, values and strategies have for the most part remained unchanged. The learning that took place was realized only within the economic network, as the company did not involve other networks.

The findings of my research confirm the suggestion of Jiménez-Jiménez and Sanz-Valle (2011) that organizational learning influences performance through innovation processes. The projects with the more diverse Inter-Organizational Learning Systems generated the more enduring innovative processes and more successful outcomes in terms of management satisfaction.

The degree of sustainability of the projects' outcomes

Application of the framework developed by Klewitz and Hansen (2011, p. 21) helps to illustrate differences in the learning and innovation trajectories between the two projects. The Rofire project was more market driven, used a more innovative environmental strategy, and collaborated predominantly and voluntarily with knowledge institutions and other external partners. The DLE project, however, was more policy driven and reactive, and it was driven by regulation and the relationship with governmental authorities. The Rofire project explicitly included social aspects in its approach (namely, the effects of the new production facility on the living climate of neighboring residents) and can therefore be called a sustainable innovation project. Social aspects did not play a role in the DLE project, which therefore makes it an environmental innovation project (following the classification developed by Schiederig et al (2012).

8.4 Common characteristics of the projects

Table 8.2 presents the characteristics that are common to all four projects, regardless of the level of management satisfaction with their outcome or the kinds of issues they focused on.

In all projects, frictions and conflicts between people were experienced as unpleasant, and managers generally tried to prevent conflicts. If differences of opinion and tensions arose, managers tried to keep the communication between actors going to prevent escalation. This approach has supported the continuation of processes of social construction. Looking back, it can be concluded that strong differences of opinion eventually stimulated more focused problem and concept definition, deeper research and the development of alternative solutions. This was a feature of all of the projects.

Table 8.2 Common characteristics of the projects

	Aggregate Aspect		
	C. Innovation Processes Development	**D. Inter-organizational Learning Systems Development**	**E. Innovation and Learning Capabilities Development**
5. Common characteristics of the projects	– The discovery of new options depended on the reconstruction and deeper common understanding of issues by several actors – Development over time from Problem & concept development to Research & Testing and Design & implementation	– Frictions and conflicts between people were experienced as unpleasant. – Frictions stimulated more focused problem and concept definition, deeper research and the development of alternative solutions – Gradual development over time of the inter-organizational learning system	– Managers applied capabilities to research and understand technical issues, capabilities for problem analysis, solving and prevention, and other expertise related to technical subjects and processes – Management tried to prevent conflicts. Or, in the case of differences of opinion and tensions, they tried to keep the communication between actors going to prevent escalation – Dynamic capability Development over time

Furthermore, managers in all projects applied capabilities to research and understand technical issues. They applied capabilities for problem analysis, solving and prevention, and other expertise related to technical subjects and processes. This enabled them to act as a sparring partner for employees and suppliers or sub-contractors.

In none of the projects was the discovery of new options effected by just one creative or highly gifted person. Discovery and creativity depended on the reconstruction and deeper common understanding of issues among several actors, alongside with the recombination of their ideas, knowledge and experiences.

Also, in each Aggregate Aspect a dynamic development over time can be discerned. In section 8.7, these dynamics are reconstructed to attain a deeper understanding of the relationships between the Second Order Themes in the projects.

8.5 The factors that stimulated management satisfaction

Using the data from table 8.1, in this section I compare the projects in which management satisfaction was low (TFR) with those in which satisfaction was high (DLE, Rofire, Wetlaid). The factors that stimulated management satisfaction are presented in table 8.3.

The table shows that in the three projects in which management satisfaction was high, managers were involved in a wide range of innovation processes and not just in one or two. Their innovation philosophy could be implemented because it was complemented with methods and capabilities. Managers adapted the width of the inter-organizational learning systems if this was required to optimize the innovation processes. They acknowledged the need for new expertise in the innovation processes and subsequently engaged in networking to introduce new, external actors. Thus, the learning system became more complex and diverse. Next, managers promoted a process of reconstruction of issues and broad social construction of the innovations with the participation of all actors.

Fundamental to the success of projects were the application (albeit to different degrees) of a philosophy, capabilities and methods to improve common understanding and to support not only personal but also organizational development. Successful outcomes were continued when new ways of working were formalized in regular policies, work methods and organizational structures.

Table 8.3 The factors that stimulated management satisfaction (per Aggregate Aspect)

	C. Innovation Processes Development	D. Inter-organizational Learning Systems Development	E. Innovation and Learning Capabilities Development
6. The factors that increased management satisfaction	– Managers were involved in all three kinds of innovation development processes: Problem & concept development, Research & testing, Design & implementation – Managers contributed both to innovation processes development and (inter)organizational learning system Development – Paying more attention to innovation processes development than to (inter) organizational learning system development hindered the effectiveness of a project	– To facilitate the creation of common understanding and new meanings, innovation and development also took place in organizing. Project success depended on the way this organizing was given form. Positive influences were: – A diverse and complex inter-organizational learning system with both internal and external actors – A broad process of social construction with all networks – Managers who developed further regular, existing (inter)organizational innovation structures	– The existence of an innovation philosophy or policy was not a guarantee of a successful project. It had to be complemented with suitable managerial methods and capabilities in the fields of innovation processes and (inter-)organizational learning systems to become effective – A need existed for new knowledge and skills, and managers engaged in networking and actively involving others from outside the company – In 2 of the 3 successful projects, a philosophy, capabilities or methods were applied that were directed at improving communication and supporting organizational development, (e.g. by promoting common understanding about the issues and the project among the actors, through improved organizing and structuring meetings)

8.6 The characteristics of the projects focused on economic and environmental issues in comparison with those of projects focused only on economic issues

Two projects focused on economic issues alone (Wetlaid and Task Force Ruptures) and two on both economic and environmental issues (Rofire and DLE). The distinguishing characteristics of those projects focused on economic and environmental issues are presented in table 8.3. The comparison shows that in these projects issues were perceived that are more complex than in the projects that were focused on economic issues alone. The issues were of interest both to society and to the company. Not only actors from the economic network of the company participated in the learning system, but also actors from the social and ecological network that were related to the issues. This has made the inter-organizational learning systems more complex and diverse, and the processes of social construction broader than in the case of innovation focused on only economic issues. Reconstruction took place of the multiple (economic, environmental, social and technical) backgrounds of the issues.

Another feature of these projects was that decision-making was not done exclusively by one actor, but by a number of actors in the inter-organizational learning system. To some degree, joint decision-making was practiced in the DLE project, because the Provincial Government had the power to sanction the project, and in the Rofire project because of the widely varying knowledge and experience that was needed to complete the project, and also because of governmental powers. The varying views and interests, in combination with the power balances in the inter-organizational learning systems, provoked discussions and arguments. This pressured the actors into continuing their search for a deeper common understanding about the issues and the projects, in order to find a stable base for the acceptance of decisions with regard to goals and directions of development.

Table 8.4 Characteristics (per Aggregate Aspect) of the projects focused on economic and environmental issues, in comparison with those of projects focused only on economic issues

	Aggregate Aspect		
	C. Innovation Processes Development	**D. Inter-organizational Learning Systems Development**	**E. Innovation and Learning Capabilities Development**
7. Distinguishing characteristics of projects focused on economic and environmental issues, in comparison with projects focused only on economic issues	– The reconstruction of issues was performed from multiple (i.e. economic, social and environmental) perspectives – More complex, multi-sided issues	– Ecological, social and economic networks were involved – More complex inter-organizational learning system – Broader process of social construction – Joint decision-making regarding the innovation processes, on the basis of common understanding of the issues and the project	– A sustainability philosophy was present in the case of at least one influential actor – More senior managers involved

Furthermore, at least one of the actors involved applied a philosophy with regard to sustainable development. This philosophy stimulated project outcomes that contributed to sustainable development, through its influence on discussions and on the innovation processes.

Finally, more senior managers were involved in the projects. They were able to deal with the varying cultures and interests of the actors, and had developed the capacity to take a longer term, developmental and systems view than younger managers when dealing with issues.

8.7 The developments within the Aggregate Aspects

In section 8.2, I found that in all projects each Aggregate Aspect comprised a similar development process consisting of interactions between the activities that rank under the Second Order Themes. To understand the meaning of each Aggregate Aspect for the course of events in the innovation projects, I reconstruct their dynamics below.

The method guiding this step is derived from Chavers (1972). This method distinguishes three kinds of interacting elements in a concrete development project or system. These are: (1) the analytical kind of elements, that consists of the different, individual factors that take part in a project. Examples include the parts of a product, the members of a team, the actors in a network, or factors that influence someone's personal development. Then (2) there is the 'synthetic' element, in which the factors or parts are combined and which represents the (intermediate) outcome or result of a project. Examples include an end product, a vision that is complete, a workgroup, an organization or a complex expertise. And finally, there is (3) the processual element, which represents the development processes in which the analytical factors interact and transform on their way to a synthesis. Examples include R&D processes, efforts to form a team, educational activities and life processes.

The arrows 1 – 9 in the figures 8.2, 8.3 and 8.4 signify the moving focus over time within each Aggregate Aspect, from one dominant activity phase to another. Together, these movements and phases (Second Order Themes) give form to the development over time of the Aggregate Aspects.

Aggregate Aspect: Innovation Processes Development

The interviews and the analysis of the First Order Concepts make clear that in practice the three Second Order Themes were connected to each other in a dynamic, developmental way (figure 8.2). In all projects, the searching and diverging phase of problem and concept development developed (arrow 1) into a converging phase of research and testing, and that phase eventually developed into more focused design and implementation (arrow 2) to deliver end results. Design and implementation led to a new situation in which the actors made new experiences, and these then led (arrow 3) to the observation of new issues or opportunities, and stimulated new ideas. Thus, the end of the innovation process became a means to stimulate a new cycle of problem and concept development, research and testing, design and implementation.

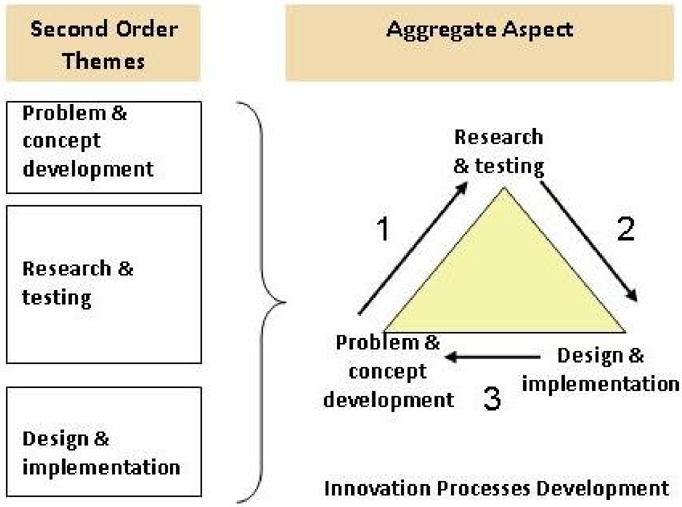


Figure 8.2 The Aggregate Aspect of Innovation Processes Development

Aggregate Aspect: Inter-Organizational Learning System Development

At the beginning of the projects, there were usually a number of actors who were related naturally to the company or societal issues at hand. Each actor had their own culture, ambitions, work methods and interests, and formal structures or informal meetings were in place to facilitate their communication. But to facilitate communication and actual cooperation, all of the projects required a developmental process (figure 8.3, arrow 4) in which structures were constructed or adapted. For example, a policy had to be reformed, meetings had to be developed, contracts had to be drawn, and teams had to be formed. Then, a transition (arrow 5) to the next phase was possible: the actual operation of the new structures that had been constructed. Through this operation, the actors were influenced in their work methods or policies (arrow 6). In the development and operation of the new inter-organizational learning system, it might become clear that additional actors were needed or that the structure had to be adapted, and (arrow 4) a new phase of actor involvement and structure development would start.

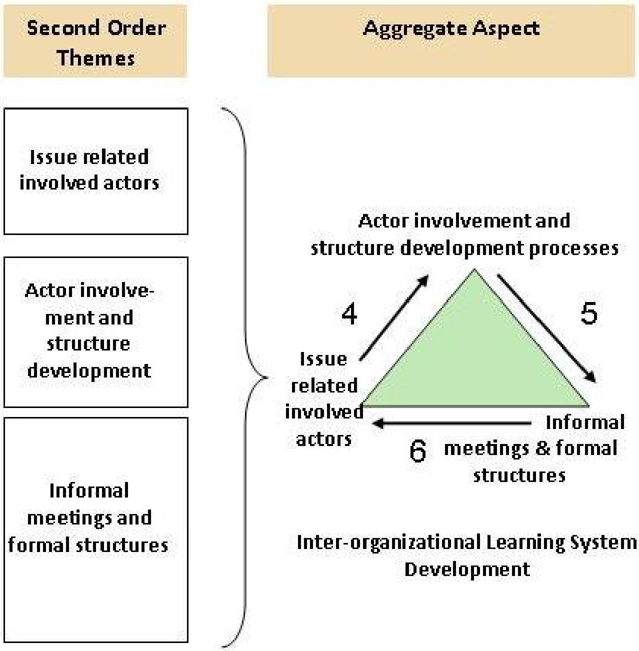


Figure 8.3 The Aggregate Aspect of Inter-Organizational Learning System Development

Thus it becomes clear that the interaction between actors, actor involvement and structure development processes, informal meetings and formal structures had the character of a system in which the involved actors learned how to best communicate and cooperate. This took place while they were working on the innovation processes. So, they learned not only about the production process or product that they were working on, but also about their own communication and cooperation, and about the structures they used to shape their cooperation.

Aggregate Aspect: Innovation and Learning Capabilities Development

The interviewees commented on the relationships between their applied capabilities and the factors that influenced their development. They tell how they inherited certain character traits from their parents and how these, in combination with influences from their family, regional and company culture, steered (figure 8.4, arrow 7) their professional development and their choice of a specific education, career or function. These educational and work processes eventually helped them to (further) develop (arrow 8) the capabilities, methods and philosophies that they applied in processes of innovation or inter-organizational learning in the project. Interviewees also mentioned that the application of their new capabilities activated (arrow 9) character traits and aspects of the company or industrial culture and, consequently, (arrow 7) new, formative educational or work experiences. Thus, the three Second Order Themes were cyclically connected in the Aggregate Aspect of Innovation and Learning Capabilities Development.

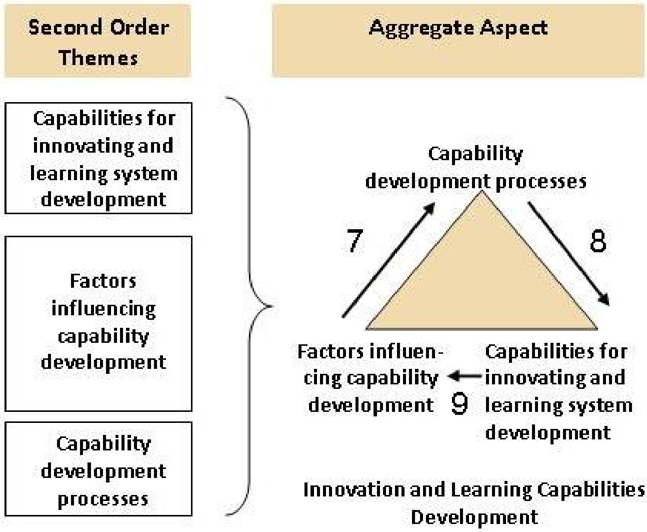


Figure 8.4 The Aggregate Aspect of Innovation and Learning Capabilities Development

8.8 The dynamics between the Aggregate Aspects

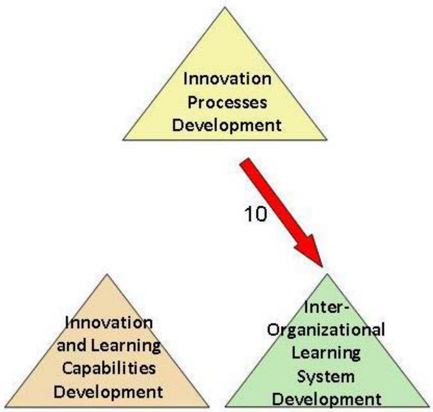
In this section, the characteristics of the relationships between the three Aggregate Aspects that are general to the four projects are mapped out. Each relationship is illustrated with a quote from an interviewee.

I show each relationship between the Aggregate Aspects using an arrow (numbers 10 – 15). Each arrow means to say that the developments in one Aggregate Aspect influence the developments in another Aspect. The interviews show that these influences run parallel to each other, and that they do not follow a specific sequence. This is understandable, as the Aggregate Aspects represent different, simultaneously operating parts of empirical projects.

Therefore, the arrows 10-15 in this section are different in character than the arrows 1-9 in section 8.7.

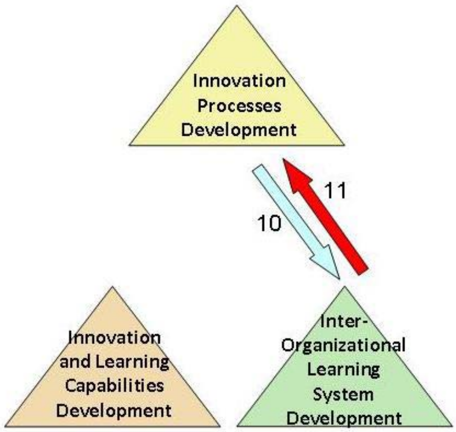
The perspective guiding the endeavor in this section is expressed well by Gioia, Corley and Hamilton (2012, p. 8): "*As important as the data structure might be, (…) it is nonetheless a static picture of a dynamic phenomenon, and process research doesn't actually investigate processes unless the static picture—a photograph, if you will—can be made into a motion picture. (…) The resulting grounded theory model, then, should be one that shows the dynamic relationships among the emergent concepts (…). Speaking in classic boxes-and-arrows terms, this process amounts to assembling the constellation of boxes with a special focus on the arrows. It is the arrows that ''set everything in motion'' (Nag et al., 2007).*"

The dynamics between Innovation Process Development and Inter-Organizational Learning System Development: Arrows 10 and 11

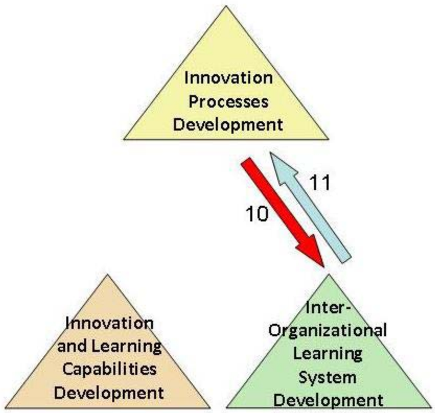


In the projects, the company ambitions and the width of the problem definition in Innovation Processes Development stimulated the development of an equally wide participation of actors in the Inter-Organizational Learning System and the further development of informal meetings and organizational structures (arrow 10). In turn, in all projects, the development of the Inter-Organizational Learning System influenced the quality (direction, width and depth) of the development of the Innovation Processes and their outcomes (arrow 11).

When examined closely, the interview data shows that each project began with a company and/or societal issue that had become apparent. This issue stimulated Problem and Concept Development processes, within Innovation Processes Development. From here on, there was an effect on Inter-Organizational Learning System Development. A Process Technician in Company C, for example, reports the following: *"The problem was that the PM-2 was performing very badly. After the restart, the number of ruptures was very high. (…) We spent a lot of time discussing this at TLD (…) We weren't able to do the tests we wanted to do on the machine because we were having so much difficulty with ruptures (…). Eventually we said, look, we're going to have to do something about this. We need to put some kind of a team together. On a couple* *of different occasions, we indicated that we felt that some changes needed to be made and that we would have to stay on top of this and carry out a full analysis. Miklas reacted well to the signals. He said: (…) We should meet on a daily basis. What kind of people are we going to need on the team? The responsibilities were shared out, (…) We spent the mornings analyzing ruptures and then came together in the afternoons to discuss and implement as many changes as we could" (Process Technician 2, Company C).*



In each project, in reaction to the innovation processes, other actors were involved and the issue was discussed first informally and later in formal meetings. The actors came to realize that their present meetings, teams, policies or contracts were not adequate in terms of facilitating the development of a solution. They started to improve existing structures or designed new ones, with the participation of new or other internal or external actors. In turn, the improved organizational structures stimulated innovation processes development (arrow 11). This is well illustrated by the following quotation: *"One of the most important aspects was that the three of us were able to dedicate our entire day to the work. That's not to say that we didn't have time for anything else, but it was certainly our top priority. (…) That was how we approached it and we found a lot of things very quickly: small things, big things, things that were causing technical problems, process technology issues, operator error, all kinds of stuff. We found out that when the PM-2 was running on a stable basis, and that you stuck to the procedure, performance improved considerably. That helped the situation immensely" (Process Technician 1, Company C).*



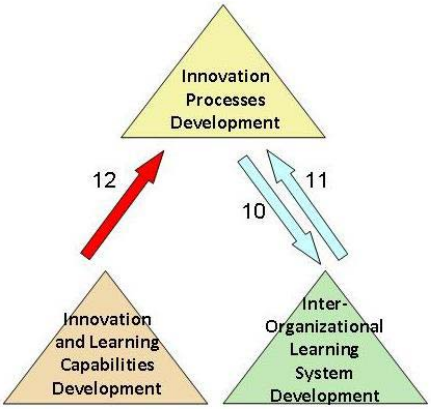
Then, the interview data shows that the actors in the modified Inter-Organizational Learning System reconstructed the histories, aspects or backgrounds of the issues in Problem and Concept Development. The issues were defined in a new way, and new ideas and concepts were developed. Research and Testing was initiated in order to deepen understanding. Gradually, insight improved and it became clear that the developing innovation processes again required other actors with complementary knowledge and experience. Therefore, there was an additional influence on Inter-Organizational Learning System Development and the common understanding among the actors (arrow 10). For example, Process Technician 2 in Company C reports the following: *"We discussed cleaning and contamination issues with each group and sought out their opinions. We discussed exactly what they did when carrying out cleaning of the machine. We did that for the PM-1 after seeing videos that showed us that holes and stains were the primary cause of ruptures. This gave the groups a better understanding of the relationship between contamination and ruptures and that was a huge step forward" (Process Technician 2, Company C).*

These interactions between Innovation Processes Development and Inter-Organizational Learning System Development continued in each project.

The dynamics between Innovation Process Development and Innovation and Learning Capabilities Development: Arrows 12 and 13

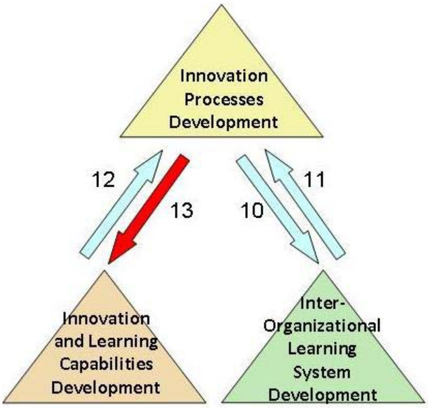
In general, in all projects, the applied innovation philosophies of managers, the diverse capabilities and the methods enabled the realization of a specific development of Innovation Processes (arrow 12). And through new work experiences, the Innovation Processes Development in turn contributed to the further development of managerial capabilities, work methods, philosophies or company competences (arrow 13).

Specifically, it was the managers who were first involved in Problem and Concept Development applied the capabilities, methods and philosophies as they had developed them in their personal and professional life. The quality of these capabilities determined the way in which the issues were reconstructed and defined, which ideas and concepts were developed in cooperation with other actors, and how further research was undertaken (arrow 12). For example, according to the Director of Operations in Company B: *"Wetlaid came about as a result of the conviction that, if you take a look at R&D in the paper industry, an awful lot of time is invested in developing drying techniques, which give paper its level of quality but at enormous cost.*



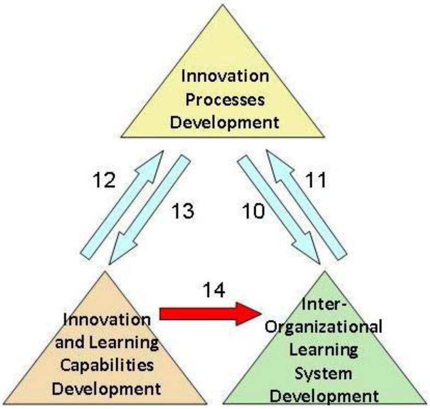
Expensive in terms of investment and in terms of energy. We figured: we could simply follow suit, if indeed we could afford to, but is this not the wrong road to be taking? Shouldn't we take the road of coming up with paper of exceptional quality by playing around with fiber? And so we started to familiarize ourselves with the use of synthetic fibers alongside paper fibers." And: *"We needed to use the network outside of the company in order to tackle these issues. The company itself simply did not know enough about fibers."* And: *"The General Director and I went to the non-woven trade fair and established some contacts. I took it over operationally then (…)" (Director of Operations, Company B).*

The Director of Operations at Company B illustrates the influence of Innovation Processes Development on Innovation and Learning Capabilities Development (arrow 13): *"We always went by the adage that it was impossible for us to implement wide-ranging process innovation here on our own steam, compared to what very large companies with their own R & D departments could do. We have since found out, however, that this idea was misleading. There are many ways and areas in which we can implement genuine, far-reaching innovation ourselves. To provide more benefits for our clients. As a result, we have now added innovation to our mission statement and that has led us to discussing how best to approach and manage innovation at the company. I don't mind saying that we have barely started scratching the surface yet on all of this. I took a course in general management last year and I chose the subject of innovation for my final project because I figured: that's something completely new for us and we need to see how we are going to approach it" (Director of Operations, Company B).* As the innovation processes developed further, the professional development also continued to be stimulated through new work experiences and changes in the company culture.



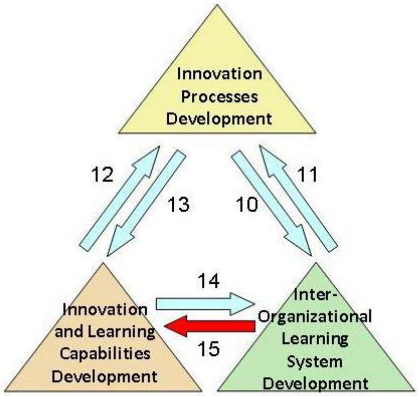
The dynamics between Inter-Organizational Learning System Development and Innovation and Learning Capabilities Development: Arrows 14 and 15

In general, the degree to which a sustainability philosophy existed in the projects or the degree to which the limits of the company competences were recognized stimulated levels of networking and the development of a more or less diverse and complex Inter-Organizational Learning System (arrow 14) through the modification and functioning of formal structures and informal meetings. For



example, Project Manager 2 in Company C illustrates this development: *"I made sure that everybody knew where we stood, what we still had left to do and what the most important challenges were. And I invested a lot of time in keeping the suppliers on board. I made sure that they knew where we stood; conflicts of interest can arise and people start getting left behind for whatever reason and there's no point in trying to drag them back into line then. So I would ask: can I help you directly or do I need to sort this out at a higher level? And I continued to explain why certain things were of crucial importance" (Project Manager 2, Company C).*

The degree of complexity of the Inter-Organizational Learning System and differences in participant cultures and interests influenced Innovation and Learning Capabilities Development (arrow 15). It specifically promoted the participation of senior managers. These senior managers were able to prevent the escalation of frictions between people and put these frictions to good use. The development of an Inter-Organizational Learning System also formed learning experiences that effected the development of Learning Capabilities. This is illustrated by the Quality Manager at Company C: *"We then brought in another project manager, Herman Jansen. He kept a tight hold on the reins and made sure that people stuck to the agreements. You're actually a kind of policeman in that scenario. And we also had to get used to that in the organization: a deal is a deal. And that is absolutely vital to a project's success"* (Quality Manager, Company C).



The result of the integration of the dynamics between the three Aggregate Aspects is shown in figure 8.5.

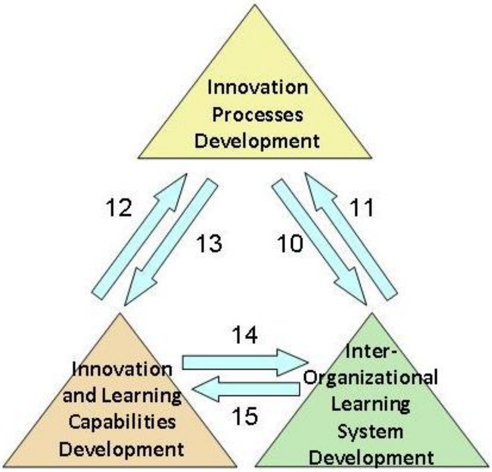


Figure 8.5 The dynamics between the Aggregate Aspects

Figure 8.5 shows that, when combined, the six kinds of parallel operating influences result in a highly dynamic development. Figure 8.5 provides a picture of the dynamics between the three main aspects of inter-organizational learning: The innovation and learning capabilities are developed under the influence of the developments in innovation processes and the platforms and other factors of the learning system that structure the interactions between the actors.

8.9 Factors that stimulated inter-organizational learning

In this section, I analyze how managerial learning has taken place and point out the factors that stimulate inter-organizational learning for innovation and sustainable development.

In chapter 2, I defined organizational learning as *the processes of social interaction in which intuitions, ideas, understandings, meanings, information or knowledge are shared and recombined in individuals, groups, teams and the organization, leading to the development of new organizational competences.* Extending this definition, *inter*-organizational learning can be said to consist of similar processes of social interaction, but then between different organizations.

As figure 8.5 shows, inter-organizational learning takes place under the influence of all three Aggregate Aspects together. Both Innovation Processes Development and Inter-Organizational Learning Systems Development provide the necessary processes of social interaction needed to stimulate Innovation and Learning Capabilities Development.

Column B in table 8.5 shows the degree of learning achieved in each project. Based on the characteristics of the Aggregate Aspects (table 8.1) in relation to these learning outcomes, Column G in table 8.5 shows two things:

1. The text that is *not underlined* shows the factors that are common to the two projects in which broader learning took place (Rofire and Wetlaid) and that distinguish them from the two with less broad learning (DLE and TFR, not shown).
2. The *underlined* text in column G indicates the characteristics of the Rofire project (which was focused on economic and environmental issues) that are different from those of the Wetlaid project (which focused only on economic issues).

Studying the overview, the following becomes clear. With regard to learning (whether it was focused only on economic or also on environmental issues), it seems to have been critical that managers engaged in networking and actively involved external actors related to the issues; that they constructed diverse inter-organizational learning systems with social and economic networks and both internal and external actors; that they organized broad processes of social construction with all networks in which they reconstructed the background of the issues from economic or technical viewpoints; that management actively tried to improve common understanding about the issues and the project among the actors, applying methods and capabilities to improve communication, e.g. by improving the functioning of regular meeting structures; and that managers were involved in a wide range of innovation processes, which enabled them to integrate new insights into formal policies and work methods.

However, next to these factors, organizational learning for innovation that was focused on economic and environmental issues also demanded that a more diverse and complex inter-organizational learning system was developed, that environmental issues were recognized, and that related actors from ecological networks were involved. And furthermore, that a sustainability philosophy was present in the case of at least one influential actor; that the economic, environmental, social and technical backgrounds of the issues were reconstructed; that joint decision-making took place on the basis of common understanding of the issues and the project in order to increase the number of actors that learned; and that senior managers participated, equipped with suitable communicative, networking, decision-making and conflict management capabilities, methods and philosophies.

Table 8.5 Characteristics of Aggregate Aspects that stimulated inter-organizational learning for innovation and sustainable development

<table>
<tr><th></th><th>B.

Learning by…</th><th>G.

Factors that stimulated inter-organizational learning for innovation and sustainable development</th></tr>
<tr><td>2. Rofire</td><td>Actors from all involved networks</td><td rowspan="2">– Management perceived economic and environmental issues

– Managers engaged in networking and actively involving external actors related to these issues

– Management had constructed a diverse and complex inter-organizational learning system with economic, social and ecological networks, and both internal and external actors. A sustainability philosophy was present in the case of at least one influential actor

– A broad process of social construction with all networks was realized. The economic, environmental, social and technical backgrounds of the issues were reconstructed.

– Management actively tried to improve common understanding about the issues and the project among the actors. Specifically, methods and capabilities were applied to improve communication by improving the functioning of regular meeting structures. Joint decision-making took place and increased the number of actors that learned

– More senior managers were involved, with a long-term and systems view; and with suitable communicative, networking, decision-making and conflict management capabilities, methods and philosophies

– Managers were involved in a wide range of innovation processes. This enabled them to integrate new insights in policies and work methods</td></tr>
<tr><td>3. Wetlaid</td><td>Actors from all involved networks</td></tr>
</table>

8.10 Concluding remarks

In chapters 5, 6 and 7, the sector and project data were presented and analyzed. In this chapter, I compared the qualitative characteristics of the three Aggregate Aspects of the four projects with each other.

A number of factors were common to all projects: All managers applied capabilities and expertise related to technical subjects and processes, though these did not seem to effect differences in outcomes between the projects. Frictions between people stimulated more focused problem and concept definition, deeper research and the development of alternative solutions, both in projects where management satisfaction was high and where it was low. The discovery of new options depended on the reconstruction and deeper common understanding of issues by several actors. Furthermore, in all projects and Aggregate Aspects, developmental trajectories over time could be discerned.

Other characteristics of the Aggregate Aspects acted as antecedents of the differences between the projects, expressed 1) in the number of actors and networks involved in learning, and 2) in management satisfaction. A comparison of the factors that contributed to higher management satisfaction (section 8.5) with the factors that improved inter-organizational learning for innovation focused on both economic and environmental issues (section 8.9) shows up the following.

High management satisfaction was attained through the construction of a diverse inter-organizational learning system in which a broad process of social construction took place with internal and external actors. It was attained through improved communication and common understanding in regular meetings, through an innovation philosophy with complementary methods and capabilities, and through managers who participated in a wide range of innovation processes but who focused on networking and improving the organizational learning system.

However, the outcome of high management satisfaction *plus* broader inter-organizational learning for sustainable development was reached through an inter-organizational learning system with the same characteristics, but complemented with the participation of the ecological network; with the reconstruction of the backgrounds of the issues from multiple (i.e. economic, environmental, social and technical) viewpoints; with the participation of experienced, more senior managers who could deal with differences of opinion and tensions between people and who had a developmental and systems view; and with a practice of joint decision-making.

Furthermore, the cross-case comparison has shown that the three Aggregate Aspects mutually and simultaneously influenced each other, and that each Aspect had its own logical development over time.

In chapter 9, the findings from the analysis (chapter 7) and cross-case analyses (chapter 8) are combined, the research questions are answered and a conceptual model is drawn. In Chapter 10, theoretical propositions and recommendations are presented.

Table 8.6 Factors that stimulated high management satisfaction in combination with inter-organizational learning for sustainable development

C. Innovation Processes Development	D. Inter-organizational Learning Systems Development	E. Innovation and Learning Capabilities Development
– Managers participated in all kinds of innovation processes but focused on improving the organizational learning system – A reconstruction of the backgrounds of the issues from multiple (i.e. economic, environmental, social and technical) viewpoints took place that facilitated the social construction of innovations	– A diverse inter-organizational learning system was developed – Ecological, social and economic networks were involved – Internal and external actors were involved – A broad process of social construction was organized – Improved communication and common understanding of the issues and the project was effected, mainly in regular meetings. – The escalation of frictions between people was prevented. – Joint decision-making regarding the innovation processes took place	– Networking capabilities were applied – An innovation philosophy and complementary methods and capabilities were present – A sustainability philosophy was present in the case of at least one influential actor – Participation of experienced, more senior managers who could deal with differences of opinion and tensions between people and who had a long-term, developmental and systems view

9 Synthesis. Answers to the research questions. A conceptual development model

9.1 Introduction

In the previous chapter, the main differences between the four projects were discovered and linked to the satisfaction of company management and the degree of inter-organizational learning. In this chapter, I answer the research questions. In section 9.2, research question 1 will be answered. Then, in the process of answering research questions 2 and 3, in section 9.3 a synthesis will be made that leads to a conceptual development model of the dynamics of inter-organizational learning for innovation. In 9.4, I evaluate to what extent my research contributes to answering the critical observations that resulted from the literature research in the sections 3.3 and 3.4. In 9.5, the Discussion, my research is related to the findings of other scholars, organized around six main themes.

In chapter 10, conclusions will be presented in the form of theoretical propositions, together with recommendations and suggestions for further research. I then also reflect on the research method.

9.2 Answers to research question 1

Research question 1: **To what extent and in which way did the processes of innovation and learning in the projects contribute to the development of changes for greater sustainable development, and what was the role of managers in these processes?**

Subquestion 1.a: **How did managers and others contribute to the projects?**

Managers have contributed to two main fields (Aggregate Aspects): the development of innovation processes and the development of inter-organizational learning systems. They did this in several ways.

By developing improved inter-organizational learning systems

Because existing informal networks and formal organizational structures were not sufficient to address the issues, managers developed new or improved formal (inter-) organizational structures as platforms for discussion, arguing, cooperation and learning. In the project where the widest distributed learning took place and where management satisfaction was highest (the Rofire project), the participants were more diverse than before. Internal and external actors who originated from economic, ecological and social networks took part. Improving existing, regular organizational structures guaranteed the integration and continuity of the innovations through modified work methods and policies. The main role of managers was in coordinating an optimal inter-organizational learning system development.

The complexity created by the multiple issues and diverse actors in the Rofire and DLE-projects has not prevented the achievement of satisfying results because new, participative inter-organizational learning systems were developed for capability and innovation processes development. The improved learning systems have helped to improve the match between the issues and the developed innovations.

The least diverse and open organizational learning system (in the TFR project) was not able to provide enough new expertise to stimulate organizational learning sufficiently. The lack of external input and diverse stimuli with regard to the creative capabilities of the actors resulted in the recurrence of old work patterns and led to a predominantly temporary effectiveness of the project.

The Wetlaid project delivered more satisfying results than the TFR project, due to the improved and company-wide organizational learning system that was open to external input. The company innovation policy and strategy were developed in cohesion with other characteristics of the learning system (e.g. direct participation and open communication for common understanding) and thus supported the development of a stable competence for systematic innovation.

By a focus on communication for common understanding

In the projects where management satisfaction was high, managers also contributed to the functioning of the project teams through focusing on the quality of communication between people. Supporting the generation of common understanding among actors facilitated the autonomy of skilled specialists, more open discussions and expression of knowledge and experience, and new combinations of knowledge, experience and ideas. This improved the quality of the outcomes of the projects. Arguments, frictions and disagreements between people did occur, but because managers prevented escalation they eventually led to improvements in the innovation processes.

By applying joint decision-making

In the Rofire project, the power of the involved actors to decide the agenda was balanced. The interests of one actor did not dominate the interests of another and the learning system implicitly operated with joint, participative decision-making on the basis of common understanding among the actors (idea: Pompe, 2008 and 2010; Dewey, 1997b). The joint decision-making stimulated actors to contribute, and as a consequence learning took place in all three involved networks.

In the DLE project, the power of the Provincial Government (as the representative of ecological networks) to counterbalance the power of Company C (representing mainly economic interests) was more crucial in the development of a broader inter-organizational learning system and process of social reconstruction than the Company had originally envisaged. The enforced broader learning system provided a greater diversity of stimuli in discussions between the actors. But because of the power imbalance between the actors, learning only took place within Company C and not with the Provincial Government.

By participating in all innovation processes

The main functions of innovation processes were to observe issues and to reconstruct and understand their histories and aspects, to create common understanding about them among the actors, to research promising directions of development, and to plan and implement innovations. The participation of company managers in the complete range of innovation processes stimulated their knowledge of the projects and the formalization of improvements in work methods, rules, organizational structures and policies, thereby anchoring the developed innovations.

By facilitating processes of social reconstruction and construction in innovation processes development

Managers in the Rofire project, in which the most widely distributed learning took place, facilitated participative reconstruction from multiple views. This shed light on more aspects of issues than in the projects with less widely distributed learning. Economic, social and ecological aspects were brought to the attention of the actors. This stimulated the innovation processes and effected an improved match between the constructed innovations and the issues, resulting in more sustainable outcomes.

The reconstruction of issues in the Rofire and Wetlaid projects demonstrated that the envisioned improvements should consist of interdependent product and process innovations, and led to the common insight that a renewal of work processes and meeting structures was needed in order to enable the innovations. In the TFR project, with its dominant economic interests and no related actors from other networks, social reconstruction processes were less broad, and the need to learn on a deeper level and to innovate more radically was not stimulated.

Subquestion 1.b: Which capabilities did they apply?

In their contributions, managers not only applied capabilities in the sense of skills, but also methods and philosophies.

Philosophies, methods and capabilities for inter-organizational learning system development
A sustainability philosophy and systems view on the part of experienced senior managers helped to identify internal and external actors from economic, social and environmental networks who were related to the issues. This supported the building of a diverse inter-organizational learning system that could generate new insights and knowledge for the resolution of both economic and environmental issues. Complementary methods and capabilities focused on networking, preventing the escalation of disagreements, and improving communication and common understanding.

Philosophies, methods and capabilities for the innovation processes development
Managers in all projects applied technical capabilities, methods and philosophies that allowed them to understand and partake in innovation processes development. These were focused on searching, imaging, researching, reconstructing and understanding issues, and on planning and executing improvements.

Innovation philosophies, methods and capabilities complemented each other at the team level
In projects with high management satisfaction, the applied capabilities, methods and philosophies for innovation and learning system development complemented each other at the team level and thus gained in effectiveness. Together they formed organizational or team competences.

Subquestion 1.c: How did they develop these capabilities?

A person's nature and character ranked highly as one of the most frequently mentioned developmental factors of influence and was often acknowledged as the main basis for professional development. Other influential factors included family and regional culture, company and industry educational culture and work methods, formal education processes and work experiences.

The more extensive life and work experience of senior managers seems to have had a positive effect on their consciousness, on the integration and complementarity of the applied philosophies, methods and capabilities, on their communicative capabilities, and on their long-term, developmental and systems view.

The development of capabilities was mainly an individual matter: None of the companies showed any sign of team-led, systematic development of complementary capabilities, methods and philosophies.

Subquestion 1.d: Which innovation processes can be discerned?

Within the innovation processes, I distinguished the Second Order Themes problem and concept development, research and testing, and design and implementation.

In problem and concept development, the focus was on the observation and definition of issues and on the development of initial ideas and concepts. This theme was characterized by a diverging, searching mode of working in which (through networking and with the help of other actors) different kinds of knowledge, information and ideas were collected and discussed. In research and testing, promising concepts were developed further, research was performed to reconstruct and gain a deeper understanding of the backgrounds of issues and to picture possible solutions. Prototypes were developed and tested, and markets were explored. These activities had a more converging and focused character. In design and implementation, the innovations were designed in detail and their implementation was planned and executed. In most projects, this phase stimulated the emergence of new issues, setting in motion a new cycle of improvement or innovation.

Subquestion 1.e: How was the discovery of new options given form?

The projects demonstrate that the discovery and realization of new options was never effected by just one creative or highly gifted person alone. It was given form through the recombination of existing knowledge, experience and ideas, tacit or explicit, residing with different actors who originated from organizations or professional cultures that did not naturally come into contact with each other. When the reconstruction of the backgrounds of issues was performed from multiple (i.e. economic, social and environmental) views, then the developed innovations were more effective.

In all projects, this crucial recombination was facilitated by informal meetings with local actors, and then by the development of new or improved formal inter-organizational learning systems. This development depended on the application of specific managerial philosophies, methods and capabilities (mentioned above under 1.b).

Subquestion 1.f: What was the role of the actors from the different networks?

In the innovation processes, actors who were related to the issue and who originated from the different networks, fulfilled several roles. In all projects, actors from the economic networks performed the largest part of the problem and concept development, research, testing, design and implementation. Participants included managers, technical specialists, researchers, consultants, suppliers or subcontractors. It was mainly these actors who initiated the development of the inter-organizational learning system.

When environmental Provincial Authorities participated, they contributed to problem and concept development, and in one project they also contributed to research, testing, actor involvement and structure development. In two projects, the environmental Provincial Authorities stimulated the discovery and development of new options and the generation of economically advantageous outcomes albeit in different ways. Actors from the social networks played a role in three of the four projects. They included a local government, neighboring residents, employees and a Workers Council, and they participated in one project in problem and concept development and in research and testing in the others .

The quality of the learning and innovation processes and the contributions to sustainable development were improved through the participation of actors from multiple kinds of networks. Conflicts and frictions stimulated more focused problem and concept definition, deeper research and the development of alternative solutions. This improvement was possible because the inter-organizational formal structures and their management were able to deal with increased complexity and prevent the escalation of disagreements caused by conflicting interests and cultural differences.

9.3 Synthesis: A conceptual model of the dynamics of inter-organizational learning for innovation

9.3.1 Introduction

The previous section highlighted the main influential elements from Inter-Organizational Learning Systems Development, Innovation Processes Development and Innovation and Learning Capabilities Development. In the sections 9.3.2 and 9.3.3, I answer research questions 2 and 3. They provide insight into the dynamics between the main aspects of the empirical learning processes for innovation and sustainable development, and the related dynamic capabilities. To do this I synthesize findings from previous chapters. Thus, a conceptual model is provided that may serve as a tool and help managers, policy makers and consultants to research, better understand and improve innovation projects for greater sustainable development.

9.3.2 Answers to research question 2

Research question 2: How were the managerial capabilities, the innovation processes, the teams, the network and the project outcomes related to each other?

To answer this question I combine the findings from sections 8.5 and 8.6 that specify the developments in and the dynamics between the Aggregate Aspects, and that were common to all four projects. In each Aggregate Aspect, a phase-like, temporal development was discerned, as shown in figures 8.2 – 8.4. Between the Aggregate Aspects, mutually, simultaneously occurring logical relationships were found, as shown in figure 8.5.

In figure 9.5, I have combined these findings into a conceptual model, which represents the answers to research question 2. The model does not prescribe a work method or process, but *describes* important aspects of learning processes that have taken place. The model abstracts from specific project features and presents concepts and their interrelationships. Thus, the model represents a conceptual picture of the dynamics of (inter-)organizational learning processes for innovation.

The developments *in* each Aggregate Aspect are characterized generically by analytical, processual and synthetical phases, as explained at the beginning of section 8.7. The arrows 1 – 9 represent moves from one phase to another. On the basis of the cross-case analyses in section 8.8, I propose that, in generic terms, the arrows 10 – 15 *between* the Aggregate Aspects represent the following logical relationships:

Arrow 10 indicates that the requirements of innovation processes stimulate the greater or lesser involvement of specific actors or a change in the characteristics or work methods of meetings and organizational structures. Arrow 11 indicates that a change in the learning system influences the characteristics and possibilities of innovation processes. These influences can operate simultaneously.

Arrow 12 shows that the capabilities, methods and philosophies of managers, and their development, limit or stimulate the actual and potential development of innovation processes. Arrow 13 indicates that developments in innovation processes, such as work experiences and changes in the company culture, influence the development of innovation and learning capabilities. Again, these influences can operate simultaneously.

Arrow 14 signifies that the capabilities, methods and philosophies of managers, and their development, limit or stimulate the actual and potential development of the (inter-)organizational learning system. Arrow 15 shows that developments in the (inter-)organizational learning system, such as work experiences and changes in the company culture and educational program, influence the development of innovation and learning capabilities. These influences can operate simultaneously.

In section 8.9, I concluded that inter-organizational learning takes place under the influence of all three Aggregate Aspects together. Both Innovation Processes Development and Inter-Organizational Learning Systems Development provide the necessary processes of social interaction needed to facilitate Innovation and Learning Capabilities Development. Without concrete innovation processes and meetings that act as platforms for communication, interaction and teamwork, (inter-)organizational learning and innovation cannot be realized. The three Aggregate Aspects are inextricably connected to each other and together they form the main aspects of dynamic development paths of (inter-)organizational learning for innovation.

This conceptual model acknowledges the dynamics and complexities of concrete projects. When applied in practice, it stimulates managers to focus on understanding the interactions and developments of the diverse aspects of innovation projects, to learn to deal with them, and to allow new insights and improvements develop.

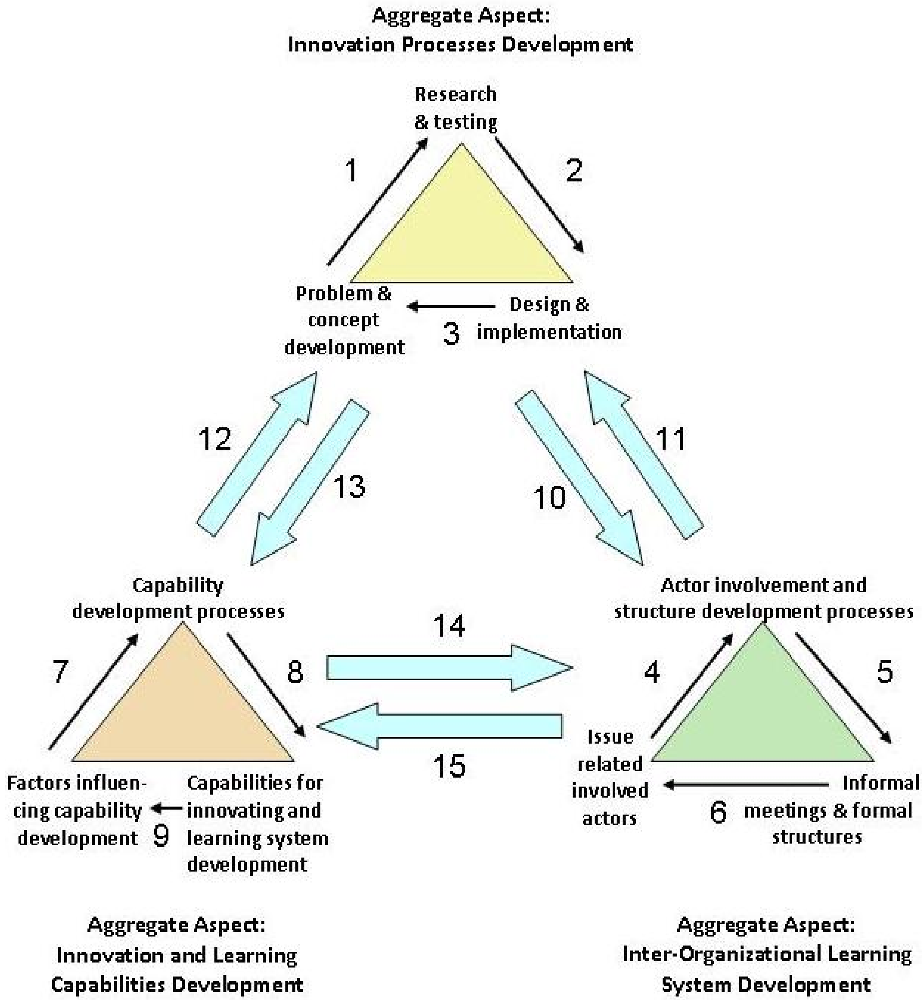


Figure 9.1 A conceptual model of the dynamics of inter-organizational learning for innovation

The model is the basis for conclusions in the form of theoretical propositions on how an organization can effectively stimulate systematic (inter-)organizational learning for innovation and sustainable development. The propositions apply if the conceptual model and the outcomes of the cross-case analyses are proven to possess validity beyond the four projects that were researched. The model offers a tool for practitioners to analyze their (inter-)organizational learning process, develop a deeper understanding of imperfections in its contribution to management satisfaction and sustainable development, and to design improvements.

9.3.3 Answers to research question 3

Research question 3: Which dynamic capabilities for innovation and sustainable development can be distinguished?

In chapter 2, I defined dynamic capability as the policies and business processes at the level of individuals, groups and the organization that enable a company to interact with its environment, to share information, to develop new and common meanings, and to develop and reconfigure capabilities and resources.

In the literature research in section 3.4, I found two major complementary perspectives on dynamic capabilities: 1) Dynamic capabilities reside in concrete managerial, regulative, communicative or organizational business processes and routines and may contain commonalities across firms; 2) Dynamic capabilities are essentially the higher level, firm-specific behavioral orientation that is expressed in the so-called adaptive, absorptive and transformative (or sensing, seizing and reconfiguring) actions of companies.

Having analyzed the four innovation projects and synthesized the findings regarding their learning dynamics in a conceptual model (figure 9.1), some concrete aspects of dynamic capabilities for innovation and sustainable development can be distinguished.

First, I conclude that in principle all second-order theme processes that rank under Innovation Processes Development and Inter-Organizational Learning System Development contribute to the development of dynamic capability. Sensing opportunities and threats in the company environment is achieved through problem and concept development, and also through the actors and informal meetings and formal structures. Research and testing contributes to sensing and also to seizing opportunities, together with actor involvement, structure development, informal meetings and formal structures. Design and implementation, informal meetings and formal structures contribute to reconfiguration.

In addition, the model suggests that the quality of the design, management and execution of the Innovation and Learning Capabilities

Development on an organizational level decides whether the development of an (inter-)organizational learning system and innovation processes becomes effective, and whether the processes that underlie dynamic capability are realized. But the influence also works in reverse order: the development of an inter-organizational learning system, innovation processes and dynamic capability also stimulates the development of innovation and learning capabilities in managers.

I conclude that if the conceptual model has broader validity, the development of a dynamic capability that contributes to systematic learning for innovation and sustainable development is strengthened by a management team that cultivates the characteristics of Aggregate Aspects as mentioned in table 8.6, namely: The perception of both economic and environmental issues; the engagement in networking and involving external actors related to these issues; the construction of a diverse inter-organizational learning system with actors from economic, social and ecological networks; the presence of a sustainability philosophy and a broad process of social construction with all networks; the improvement of common understanding about the issues and the project among the actors; the application of methods and capabilities to improve communication by improving the functioning of regular meeting structures; the application of joint decision-making; the involvement of more senior managers with a long-term and systems view, and with suitable communicative, networking, decision-making and conflict management capabilities, methods and philosophies; the involvement of managers in a wide range of innovation processes, enabling them to integrate new insights into policies and work methods; and the reconstruction of economic, environmental, social and technical backgrounds of the issues.

9.4 Considering the critical observations

I return to the four critical observations from section 3.3 and 3.4, from which the research questions originated. For each critical observation I evaluate to what extent my research contributes to an improvement.

1. “*Lack of attention to the development of methods and capabilities for discovering unknown options is seen as a serious omission in both bodies of research, especially given the importance of inventiveness in the development of sustainable options.*”

My research has reconstructed four concrete processes of discovery of unknown options. It concludes that these processes were based on teamwork and that the outcomes arose from the reconstruction of issues from multiple viewpoints and the combination of knowledge and ideas by a team of diverse actors. The related applied methods and capabilities of managers were partly technical but consisted largely of networking, building alliances, facilitating open communication, creating common understanding, preventing disagreements from escalating, and the practice of joint decision-making in regular meeting structures.

2. "*Capabilities have to be able to accommodate these very diverse perspectives while operating within a multi-organizational system that is sensitive to locality*."

My research shows that the diverse perspectives of actors can be integrated if these perspectives are applied in the reconstruction of the backgrounds of the issues. Social reconstruction from multiple viewpoints clarified the complexity and the diverse aspects of issues to the actors, increased their common understanding and stimulated their creativity. An important condition for learning collectively in a reconstruction was a balance of power between the actors. Furthermore, facilitating open communication, creating common understanding, preventing disagreements to escalate, and the practice of joint decision-making are also important capabilities.

3. *"The lack of empirically grounded models that take into account the dynamics and systemic complexities of inter-organizational learning processes for sustainable development does not help policy makers and managers to picture, understand and systematically facilitate these processes in practice and to realize consistent progress towards sustainable development*."

The conceptual model that was designed in section 9.3.2 is empirically grounded in the dynamics and complexities of concrete innovation projects. It includes the main aspects of the learning processes, the developments over time of these aspects, and their interrelationships. It constitutes a tool that can help policy makers and managers to systematically realize progress towards sustainable development.

4. *“Research that provides deeper insight into the factors that have a critical influence on the quality of empirical inter-organizational learning processes and the development of dynamic capabilities, contributes to the design of more dynamic models for systematic learning for innovation and sustainable development.”*

My research presents the main factors that have influenced concrete inter-organizational learning processes, including their interrelationships and developments over time. It delivers a conceptual model that facilitates more systematic learning for innovation and sustainable development.

Reflecting on the answers to the four critical observations, I conclude that my research has contributed to deeper understanding and to bridging the gap between the theory and practice of inter-organizational learning for innovation and sustainable development.

9.5 Discussion

In 9.2-9.4, I presented the main findings of this research as answers to the three research questions and four critical observations. They are based on the analyses and cross-case analyses in chapters 7 and 8. In this section, I compare the findings from my research to those of other scholars. The section starts with a summary of this exercise (9.4.1) and then goes on to present the detailed findings. I first compare the findings of my research with those of authors who in the past have laid down important bases for the modeling and management of system dynamics and change (9.4.2). Then (9.4.3 – 9.4.7), I evaluate the findings along five themes, namely the dynamic and learning perspective on innovation projects, the organization of (inter-)organizational learning, management capabilities, capability development, and dynamic capabilities for innovation and sustainable development.

9.5.1 Summary

The fundamental concepts and outcomes of my research are supported by the findings of authors who, up to 50 years ago, laid the foundations for the concept of sustainable development and systems thinking. My research contributes insights and methodical suggestions for dealing systematically with the empirical wicked problems, messes, and domain-related meta-problems that first caught the attention of these authors. It contributes a model that suggests ways in which to picture and understand the dynamics of different inter-organizational learning system aspects.

The aspects of innovation projects that this research has inventoried and that were seen to have been influential in the generation of (inter-)organizational learning for innovation, are supported by the research of other scholars. I have also modeled the interrelationships and dynamics between these aspects in a manner that suggests ways in which to systematically picture, preview and manage the dynamic, empirical development of an inter-organizational innovation project. The usefulness of the learning perspective is supported by literature.

Various authors acknowledge the need for suitable structures to facilitate inter-organizational learning. It is widely recognized that openness, participation and organizational democracy are valuable qualities with regard to these structures for learning and improvement. Some authors mention the negative influence that a dominant interest exerts on the quality of organizational learning, but in general the connection between power imbalances between companies and other actors on the one hand and suppressed involvement, creativity, innovation and sustainable development on the other hand is not made. The need suggested in this research for participative business models that apply joint decision-making is implicitly supported by other authors, and it is similar to the advice of Beer (1972) that an organization be structured along the principles of flexibility, redundancy and freedom. Scholars support my finding that innovation for sustainable development is a societal challenge that requires the integration of the knowledge of outside actors into the company.

The finding in this research regarding the positive effect on innovation of a management style that focuses on open communication and participation is supported by the findings of several other authors. They stress the value of management that facilitates the participation, autonomy and freedom of employees. Also, the importance of capabilities for careful reconstructions of the histories and different aspects of societal and company issues, for a deeper understanding of issues and for the subsequent innovation of products, processes and organizational structures, is supported by other authors. And the role of networking capabilities in innovation projects is also recognized by other scholars.

Unlike in this research, only a few of these scholars refer to the origins of management capabilities, or to ways in which their development can be stimulated. Those who do mention the subject do so only in general terms. The studied literature does not make any mention of the connection between the development of management capabilities, structures for learning and innovating, and innovation processes, as this research does.

Finally, my research identifies relationships between the development of dynamic capability, organizational learning and sustainable development that have also been proposed by other authors. The model developed in this research shows how dynamic capability can be systematically developed and managed, and applied to generate innovation for sustainable development.

9.5.2 Evaluation against the historical roots of the modeling and management of system dynamics and change

Roome (2013a) presents an overview of the original ideas that contributed to the Brundtland report (Brundtland, G-H., 1987) and Agenda 21 (United Nations Department of Economic and Social Affairs, Division for Sustainable Development, 1992). These ideas stem from the research fields that deal with systems science and cybernetics, social complexity and the interaction of people in teams and organizations. Despite this connection, the systems view and the subject of systems change have not found their way into mainstream literature or company practices (Roome, 2013b). The fact that my research has moved in these fields justifies an evaluation of my findings against those of the founding fathers of the body of thought on sustainable development and dynamic, open systems thinking.

Systems science and general systems theory

In this field, the authors Ashby (1962), Von Bertalanffy (1968), Beer (1972), Meadows et al. (1972), United Nations (1972), IUCN (1980) and Boulding (1996) have all delivered fundamental contributions.

Ashby (1962) has developed propositions regarding the principles of self-organizing systems. He finds that an organized whole is dependent on communication between its parts, and that the properties of a specific organization are “*(…) not intrinsic to the thing but are relational between observer and thing*” (p.258). “*(…) any dynamic system can be made to display a variety of arbitrarily designed parts, simply by a change in the observers view point”* (p.260). Ashby proposed that “*(…) there is no property of an organization that is good in any absolute sense; all are relative to some given environment, or to some given set of threats and disturbances, or to some given set of problems*”(p.266), and that “(…) *Every dynamic system generates its own form of* *intelligent life, is self organizing in this sense*” (p.270), under the condition of the amount of variety that can be perceived by a *“(…) regulatory or selective device”* (p.274). My research confirms Ashby’s propositions that different actors observe and value the issues and properties of the systems that they are dealing with differently, and that the common observation of an increased variety of data on the issues and systems eventually helps to develop acceptable definitions of issues and select solutions. My research shows that the development of a “*regulatory or selective device”* (Ashby, 1962, p.274) is a process in itself if multiple and diverse actors are involved, without guarantees of success, and that the outcome of such a process is linked to the capabilities of the involved managers.

Von Bertalanffy (1968) has endeavored to build theory regarding the foundations, developments and applications of the open system concept in diverse sciences. He proposed that “*While in the past, science tried to explain observable phenomena by reducing them to an interplay of elementary units investigatable independently of each other, conceptions appear in contemporary science that are concerned with what is somewhat vaguely termed “wholeness,” i.e., problems of organization, phenomena not resolvable into local events, dynamic interactions manifest in the difference of behaviour of parts when isolated or in a higher configuration, etc.; in short, “systems” of various orders not understandable by investigation of their respective parts in isolation”* (p.36-37). “*The mechanistic concept of nature predominant so far emphasized the resolution of happenings into linear causal chains; (…) In contrast to this, in the theory of open systems (…) principles of multivariate interaction (…) become apparent, a dynamic organization of processes (…)* (p.154). Von Bertalanffy concluded that human mental categories serve to order the complex systems of reality, and that these categories have evolved under the influence of perception and experience, which have guided *“(…) the organism in such a way as to preserve its existence*”. However, he says, the categories and the knowledge resulting from them have been influenced by biological and cultural developments and scientific “*de-anthropomorphization*” (p.247). They are colored by the perspective from which reality is studied, and therefore *“(…) knowledge only mirrors certain aspects or facets of reality*” (p.248).

The findings in my research support the open systems view of Von Bertalanffy. Following a similar line of thinking, they suggest that an innovation project is best approached as a developing system with multiple aspects, and that it can best be managed on the basis of the combined knowledge of different actors who observe the project from multiple perspectives. The model that has resulted from my research makes the open and dynamic systems concept concrete for the researched projects and helps to translate it in terms of management development, innovation, learning and organization.

Beer (1972) has studied which organizational structure and ways of regulation promote the viability of firms. He saw a firm as a system with feedback loops, and he proposed a structure and communication method that resembles the workings of the human nervous system. He concluded that to make decisions that support the viability of a firm, it is necessary to identify the logical aspects that are involved in a complex situation, to identify the relationships between them, and to nest the variables that are involved in these different aspects. This procedure, he argued, offers a search logic (heuristic) and helps to rapidly reduce variety and uncertainty. Evaluating the model that has resulted from my research (figure 9.5), I conclude that, as Beer advised, it has indeed identified the logical dimensions (aspects) that played a main role in the innovation projects, along with their variables (First Order Concepts and Second Order Themes), relationships (arrows 1-15) and developmental paths (the thick descriptions).

Research by Meadows et al (1972) drew attention to the negative effects of human activity on resource availability and ecological systems. A "*World Model*" (p.102-103) was constructed to study the interconnections between and the development over time of industrialization, population growth, malnutrition, depletion of resources and environmental degradation. The model was built from a philosophy of systems thinking, using feedback loops, simulating the dynamics of reality and applying a long-term perspective, with the intention of predicting the behavior of the world system in the future.

A system dynamics philosophy also forms the basis of the findings and the model in my research. However, working with a different scale, my findings suggest (inter-)organizational, innovational, developmental, educational and managerial aspects, and processes and interrelationships that help to successfully manage the dynamics of inter-organizational learning in a concrete innovation project for sustainable development.

In the recommendations of the Conference on Human Development (United Nations, 1972) the linkages between environmental protection and improvement on the one hand, and human settlements, well-being and (economic) development on the other, have explicitly been acknowledged. The need to work from a philosophy that integrates ecological, social and economic systems is also expressed by IUCN (1980): "*Essential ecological processes are those processes that are governed, supported or strongly moderated by ecosystems and are essential for food production, health and other aspects of human survival and sustainable development. "Life-support systems" is* *shorthand for the main ecosystems involved – for example, watershed forests or coastal wetlands. The maintenance of such processes and systems is vital for all societies regardless of their stage of development"* (p.22). In relation to this, my research provides methodical suggestions on the development of an integrated philosophy by showing how it can result from platforms that are based on participative structures and joint decision-making and that facilitate the discourse between actors from different networks, guided by senior managers with specific capabilities.

Boulding (1996) presented the earth as a closed system in which energy, material and information sub-systems are important. It will eventually operate as "(…) *a single spaceship, without unlimited reservoirs of anything, either for extraction or for pollution (…)*" (p.303), and that situation will create problems for our ways of producing and consuming. "*Our success in dealing with the larger problems (…) is not unrelated to the development of skill in the solution of the more immediate and perhaps less difficult problems. One can hope therefore, that (…) a learning process will be set in motion (…)"* (p.309). My research supports the systems view proposed by Boulding, and provides methodical suggestions for the generation of skills and knowledge for the design and management of multi-actor, system-related learning processes for innovation.

Social complexity

Research by Rittel and Webber (1972) and Ackoff (1974) has generated original insights on the subject of social complexity that are relevant to sustainable development. Rittel and Webber (1972) suggested that planning by professionals is no longer accepted and sufficient in a society composed of groups that interact, that have different interests and value systems, and that together form dynamic systems. Defining and locating problems, and identifying suitable actions, has become very difficult. The authors introduce the term "wicked" planning problems. A wicked problem has no definitive formulation, no stopping rule, and no true or false solutions. A solution cannot be tested very well, there is no opportunity to learn by trial-and-error, and the set of permissible operations and solutions is not limited or well described. Every wicked problem is unique, can be considered as a symptom of another problem, and can be explained in numerous ways. The actions of planners matter a great deal to the people that are affected by those actions. These characteristics make planning "*a component of politics*". Rittel and Webber conclude: "*We have neither a theory that can locate societal goodness, nor one that might dispel wickedness, nor one that might resolve the problems of equity that rising pluralism is provoking. We are inclined to think that these theoretic dilemmas may be the most wicked conditions that confront us*" (p.27).

In my research, wicked societal problems occur in the Rofire and DLE projects. The issues in the TFR and Wetlaid projects also display the characteristics of wicked problems, albeit on a more limited scale. The conceptual model that I developed (figure 9.1) pictures the dynamics and influential factors that enable actors to create a deeper common understanding about a specific concrete wicked problem as a basis for political decisions, the development of "*societal goodness*" and the resolution of "*problems of equity*" (Rittel and Webber, p.27).

Ackoff (1974) suggested that "*The present worldwide concern with readjusting personal and social priorities reflects a greater and more pervasive concern with the problems we have failed to face than with those we have faced unsuccessfully"* (p.8). To be successful, we should develop a "*philosophy and world view*" (p.8) that acknowledges that our world consists of complex systems that generate problems that cannot be dealt with by reductionism, analytical thinking, thinking in cause-effect relationships and closed systems. To deal with systems, a "*synthetic mode of thought"* is needed (p.14). "*(…) in systems thinking an attempt is made to evaluate performance of a system as a part of the larger system that contains it"* (p.15).

Ackoff distinguished three kinds of problems in the management and control of systems: *"(…) the self control, the humanization and the environmentalization problems"* (p.18). He urged us to realize that *"(…) no problem ever exists in complete isolation*" and that it is part of a system of problems, which he calls "*a mess*" (p.21). Dealing with these problems requires interactive planning that is participative (everyone who is affected should take part), coordinated (all aspects should be planned for, simultaneously and interdependently), integrated (integration of the different levels in an organization) and continuous (because systems and environments are changing continuously) (p.28-29). In addition, "*Humanization of an organization requires making its objectives compatible with those of its individual members so that they are mutually reinforcing*" (p.45), and "*Environmentalization is the process of putting into a system's mind its relationship to the whole of which it is part"* (p.55). Corporate responsibility requires considering the interests of all stakeholders. "*All the participants and those affected by it invest some type of resource (including themselves) in it. Why should the stockholder be singled out and be permitted to dictate corporate objectives? (…) The average employee probably has more to lose by his employing corporation going out of business than does the average stockholder"* (p.63). Therefore, Ackoff proposed, *"(…) the board should have members who look out for the interests of the six groups of participants as well as of the corporation as a whole"* (p.66). Environmental deterioration can be prevented *"(…) by bringing into public and private organizations advocates of environmental improvement and giving them access to the power and resources required to assure contributions to improvement of the environment*" (p.68).

My research supports Ackoff's propositions and confirms the open and multi-actor systems-character of the issues that were addressed in the innovation projects. These issues can be characterized as *messes*: they could not be solved in isolation and were connected with other issues. Each company in the research was confronted with the fact that decision-making was influenced by actors other than the stockholders, in and outside the company, who were affected by the issues and who had invested in the company in various ways. My research acknowledges that more participative business models are needed with balanced powers. It suggests a set of complementary capabilities, methods and philosophies that are related to the development of learning systems and innovation processes that are useful when trying to deal with *messes*.

People, teams, organizations and ecologies

In this field, research by Emery and Trist (1973), Trist (1983) and Emery and Purser (1996) can be characterized as fundamental to problem solving for sustainable development. Trist (1983) has described how the emergence of meta-problems provokes the need for inter-organizational collaboration at the domain level. The required capability for development of an inter-organizational domain is provided by referent organizations controlled by (local) stakeholders who concretely experience the meta-problems in the domain.

My research has studied company and societal issues that consist of sets of problems in which various kinds of actors participated. Although not whole domains were involved, the characteristics of the issues in two of the four projects were similar to those of the meta-problems that Trist referred to. To contribute to the development of inter-organizational domains, Trist advises processes of "*Network initiatives, fostering appreciative learning, designing appropriate referent organizations, and convening the extended social field* –" (p.282), each again consisting of sub-processes. These processes can all be recognized in my findings. My findings also introduce other involved management capabilities, the team-aspect and the processes by which the different aspects develop. They picture the mutual relationships between the aspects of the innovation projects, and include their development over time. They also include attention for processes of discovery and innovation.

Building on earlier work and extensive practical experience, Emery and Purser (1996) presented a participative, democratic planning method for planning more successfully in turbulent environments. A turbulent environment is characterized by *"*(…) *unpredictable interactions and enmeshed connections between different facets and groups in society. The long-term effects of organizational actions in turbulent fields are also difficult to predict and trace.* (…) *small errors can be amplified beyond all expectations.* (…) *dramatic and unpredictable shifts in social values produce high relevant uncertainty and institutional instability*" (p.59). Their method, the Search Conference, "*(…) allows people to learn about their system in its environment, and see how they have created the system and world that they live in today*" (p.5). It leads to *"(…) the development of a learning-planning community, that is, a large group of people who know how to learn and plan together*" in which people *"(…) have the freedom and right to exercise individuality and autonomy"* (p.8). A Search Conference is built on the principles of open systems thinking; getting the right system in the room; puzzle solving and direct perception, not expert-driven problem solving; democratic structure; meeting conditions for effective communications and dialogue; and searching for common ground by making conflicts rational (p.33). In the conference, "(…) *conflict* [is treated] *as one of the natural by-products of creative group activity. Disagreements allow participants to do a reality check on their ideas*" (p.218). Fred Emery, who organized a first Search Conference in 1960, states that the method was actually rediscovered, and that it is based on principles that were already applied by tribes much earlier in the history of mankind. Because of its focus on learning in a structured, social setting, the concept of the Search Conference supports the concept of Inter-Organizational Learning System Development that has been developed in my research. Through its focus on searching, reconstruction and common understanding, the concept of the Search Conference also supports Innovation Processes Development.

9.5.3 A dynamic and learning perspective on innovation projects

This research proposes that innovation projects are characterized by different aspects that interact in a dynamic way and that all have their own development process. This perspective is at least partly supported by other authors. The picturing of the elements and the dynamics of the development processes that has been done in this research is the main difference between it and other research that also identifies different influential aspects and factors.

The model developed in section 9.3 presents relations similar to the ones between learning processes, innovation processes and the organization of work and organizational culture developed by Høyrup (2012, p.12). The factors that influenced the innovation management in the four studied projects are all mentioned in the literature review of Smith et al (2008). My research also demonstrated the dynamics between all of these factors.

Case study research by Swift and Hwang (2008) supports my findings. In a narrative way, it shows how in one company organizational learning is supported by the interdependencies and dynamics of organizational processes, flexibility, teamwork, transformation of individual into organizational learning, and transformational processes. Case study research by Narayanan et al (2009) identifies managerial and organizational, structural factors that are relevant in the development of dynamic capabilities. The same holds for the research of Siebenhüner and Heinrichs (2010, p.196) that finds that sustainable development needs collective learning, supported by committed individuals, structures that facilitate innovation and innovative project designs. Also, other research (e.g. Frishammar et al., 2012; Dasgupta and Gupta, 2009; Jiménez-Jiménez and Sanz-Valle, 2011; Barker Scott, 2011; García-Morales, 2006; Smith et al., 2008; Sambrook, 2005; Dixon, 1992) mentions relevant factors for performance, organizational learning or dynamic or innovation capabilities. However, these authors do not mention the interrelationships between these factors, their dynamics and developmental aspects, or the managerial capabilities that would enable their integration and realization. Heugens (2005) also indicates that the development of organizational knowledge is a highly context- and path-dependent process that ideally consists of sub-processes, facilitated by managers, of interaction between employees, reflection, and the combination and integration of knowledge.

In the Rofire, DLE and Wetlaid projects, management capabilities, methods and philosophies contributed to the creation of organizational-cultural characteristics that many scholars say promote organizational learning, namely experimentation, autonomy, risk taking, teamwork, availability of resources, employee participation, cooperation, an external (customer) orientation, a learning orientation, dialogue and flexibility. In the less successful TFR project, management capabilities, methods and philosophies cultivated cultural characteristics that are considered (Sanz-Valle et al., 2011; Alegre and Chiva, 2008) to hinder learning and orientation, namely a lack of employee participation, an internal orientation and a focus on stability and control. The research by Cloudt and Geurts (2012) also mentions some of the aspects of socially oriented organizations that I have distinguished. However, the research does not mention the necessary development processes, e.g. with regard to power structures.

The finding that a learning perspective or paradigm helps to promote insight into the dynamics and values of concrete innovation processes is supported by several scholars, e.g. by Yu (2011) who has researched learning in relation to intellectual capital development: "*(…) the content-focus definition of IC* [Intellectual capital – Hvk] *could not determine the value of IC. (…) the practical focus of a learning paradigm in the field of IC was to enable a non-linear process of learning, in which the concept of IC could be assessed in relation to its enabling, or blocking, of a focal organisation's potential to change and innovation"* (p.249-250).

Lampela (2009) finds that managers need to acknowledge the complexities of operating environments for innovation, and finds a related need to support learning more systematically to take advantage of learning in networks. The results of research by Jiménez-Jiménez and Sanz-Valle (2011, p.414) *"(…) may imply that organizational learning influences organizational performance mainly by facilitating innovation."* Also, the finding of Siebenhüner and Arnold (2007, p.348) is relevant, that *"(…) sustainability oriented learning obviously requires the adaptation of existing learning mechanisms and the development of company specific solutions. A generalized instrument seems not to be available."* But, as Wang and Ahmed state (2007, p.44), "(…) *capability development is time dependent.* (…) [It] *does not necessarily produce immediate results*." A consistent long-term vision and a focus on long-term performance are crucial.

9.5.4 The organization of (inter-)organizational learning

My research indicates that a dynamically developing, inter-organizational learning system helps to realize innovation processes and build managerial capabilities and organizational competences. Participative structures and joint decision-making facilitate the effectiveness of such a system. The findings are supported by several authors.

(Participative) structures, (joint) decision-making, and (inter-)organizational learning

The crucial role of (inter-)organizational structure that this research has found is supported by the earlier work of Roome (2001c, p.24): *"Organizations that are able to combine the generation of new ideas through experiments for sustainable development with the operation of a more formal organization structure will have the basis for leadership in sustainable development."*

Rondeaux et al (2009) define certain good practices to promote inter-organizational learning, and thereby refer to capabilities that this research also found that facilitate learning systems development. Also Banyan (2010), Frishammar et al (2012) and Muff et al (2013b) stress the dominant importance of the design and management of a suitable infrastructure for inter-organizational collaboration towards sustainable development. Sanz–Valle et al (2011) refer to the stimulating role of an external orientation and an adhocracy culture for organizational learning. These aspects are similar to philosophies and methods of managers applied in the successful projects in my research, and they confirm the importance of qualitatively suitable structures in inter-organizational learning.

Siebenhüner and Arnold (2007, p.346) found that *"All the companies have created structural provisions for the initiation and diffusion of learning processes. No company has been able to generate organizational learning processes for sustainability without such a structure."* They refer to the important role of executive support for sustainability-related requirements and organizational learning. Nooteboom sees the ability of governance primarily from the perspective of dealing with relational risks, and secondarily as an ability to organize or structure collaboration in or between organizations and to integrate variety "(…) *into a new organizational focus*" (p.205). Hargadon (2003) suggests that bridging different worlds is not enough: building new organizational structures is also necessary to further develop new combinations of knowledge and experience, and to make them productive. However, these studies do not throw any light on how to develop these capabilities in interaction with the processes of innovation and other factors.

My research demonstrates that an (inter-)organizational learning system that works with joint decision-making based on common understanding improves learning with the actors, tends to promote double loop learning and radical changes, and promotes more sustainable development philosophies, methods and outcomes. The finding that participative, learning systems with joint decision-making are useful in business is in accordance with the view (Nooteboom, 1997b, p.5) that "*(…) the need* [of a firm – HvK] *to achieve a focus entails a risk of myopia: relevant threats and opportunities to the firm are not perceived. To compensate for this, people, and firms, need complementary sources of outside intelligence, to utilise 'external economy of cognitive scope'.*" My research makes clear that the TFR project suffered from 'myopia', that the DLE project was forced out of its 'myopia' by the Provincial Authorities, and that the Rofire and Wetlaid projects recognized from the beginning that *"(…) innovation derives primarily from interaction between firms"* (Nooteboom, 1997b, p.5). Siebenhüner and Arnold (2007, p.346) found that *"(…) interdisciplinary cooperation was described by interviewees as beneficial for sustainability-oriented learning processes to meet the particular challenges of sustainable development lying in the interface between economic, ecological and social issues."*

My findings regarding participative (inter-)organizational learning systems also correspond with the findings of Høyrup (2012) who finds that dominance and protection of vested interests hinder learning processes and that openness, participation and actor diversity in the work organization and social systems provide the intellectual stimuli needed for creativity and learning: "*(…) as regards to innovative learning, tension, conflict and ambiguity may not be seen as threats to learning, but rather as potential triggers of developmental learning"* (Høyrup, 2012, p.26). Billett (referred to in Høyrup, 2012), states that learning and innovation are connected with each other by the degree to which employees contribute to and are allowed to participate in work. However, *"Organizations implement participative decision-making to benefit from the motivational effects of increased employee involvement, job satisfaction and organizational commitment"* (Alegre and Chiva, 2008, p.317), but seemingly do not do this with the aim to improve the quality of the information, knowledge and experience introduced into the learning processes.

The importance of a shared vision is expressed by Garcia-Morales et al (2006, p25): "*The absence of shared vision has been analyzed as one of the most important causes of failure for the processes of OL* [organizational learning – HvK]. *(…) However, imposing instead of sharing the vision will not breed OL but apathy, complacency and even resentment (…).*'

The potentially positive effects of organizational democracy are confirmed by the research of Weber et al (2009) who find that "*(…) it can be assumed that participative and democratic practices may enhance prosocial work orientation, as well as identification with the organization and employee commitment*" and that "*(…) there is reason to believe that democratically structured companies may enhance societal cohesion in the long run (…)*" (p.1144). Butcher and Clarke (2012) stress that good governance by companies is stimulated by democratic debate within the organization. However, this needs a change from the dominant "*rational mindset*" (p.234) that is dominant in business and business schools to a "(…) *mindset that values diversity of opinion and the constructive political processes required to reconcile competing agendas*" (p.234). Castiaux and Paque (2009, p.120) find that participative innovation "(…) *allows to meet both quality and innovation management requirements."* My research found, in the case of two successful companies, not so much a democratic mindset focused on moral engagement, but a focus on improving organizational learning to solve primarily company issues. This agrees with the findings of other authors.

Concerning the role of managers, the following can be proposed: In more participative organizational learning systems, managers may take the less controlling roles of coordinating and systematizing learning and innovation processes, and inviting actors to participate (Høyrup, 2012), as was found in the Rofire and Wetlaid projects.

Learning to learn in inter-organizational settings

Nootboom (2009, p.121) proposes that: "*Organizational focus yields a constraint that can be compensated by outside collaboration*." My findings confirm this statement, but also indicate that the constraint may not be felt by a company because it does not generate a company issue but rather a societal issue. Scholars who have studied partnerships from an actor perspective suggest that partnerships may contribute to innovation and sustainable development by the generation of financial means and access to markets, by the input of local expertise and knowledge, by accelerated learning and accumulation of knowledge, and by the enhancement of a company image and the gaining of legitimacy (Van Huijstee, 2007, p.82-83). At least a number of these contributions are confirmed by the Rofire case.

Dyllick (2004, p.10) suggests that working on sustainability issues, "*Companies should concentrate on that subject where they have a special competence and can deliver a special contribution"* and that *"In companies an explicit explanation and definition of the sustainability policy and strategy is needed."* Heugens et al (2008) demonstrate that the development of a moral community that has institutionalized certain ethical principles is possible if top and middle management transform themselves and succeed in preventing moral stagnation or moral drift. Their findings imply that organizational learning depends strongly on the available managerial skills and philosophies, and also on the business model, on the organizational structure and on the way management applies its power.

My finding that learning and innovation towards sustainable development need new business models is supported by Boons et al (2013) and Boons and Lüdeke-Freund (2013). The latter present normative requirements for the value proposition, the supply chain, the customer interface and the financial model needed to develop business processes and systems of production and consumption that contribute towards sustainable development. As an addition, my research identified the need for a balance of power in new business models between the involved actors, to induce greater participation and dialogue, more information and recombination of knowledge, experience and ideas, as bases for collective learning and the generation of the more sustainable value propositions, supply chains, customer interfaces and financial models, as advised by Boons and Lüdeke-Freund (2013).

Having studied the lack of progress towards sustainable development that has been documented over many years (see the sections 1.1 to 1.3), the course of events in the researched projects and the aforementioned findings, my research indicates that innovation in the ways of learning and innovating in business is a challenge that cannot be accomplished by business alone. It is a societal issue that justifies societal involvement. The economic rewards of greater ecological performance can be realized when a more inclusive approach is taken and when the related innovation system is expanded. This has also been suggested by Boons and Wagner (2009). My study clarifies some management approaches that can be useful in this effort.

Having to deal with large-scale and messy problems, society may look at innovation in the ways of learning and innovation in business from an institutional perspective and see partnerships between business, governments and societal actors as platforms or systems for learning and innovation, and "*as new arrangements in the environmental governance regime*" that combine *"(…) Business for economic development, government for the protection of public goods (of which social and natural capital are important aspects), and civil society for the enhancement of civility and social cohesion (…)"* (Van Huijstee et al., 2007, p.76 and 79), under the condition that these partnerships are legitimate. Sondeijker et al (2008, p.27) suggest that the method of transition management and scenario building may contribute to the creation of novel societal development paths, but that this would need *"(…) a synthesis in existing scenario methods, consisting of new combinations in prevailing scenario methods and innovations in existing methods.*" My research suggests that the creation of platforms in which a balance of power exists between actors may improve our understanding of the world, and consequently improve the imagining, scenario building and transition management that are founded on such an understanding.

More participative inter-organizational learning systems that help actors from economic, social and ecological networks to cooperate, to balance their powers and to develop sustainable solutions, will sometimes develop spontaneously and voluntarily, but will at other times have to be stimulated by government policies and legislation. This is shown by the DLE and Rofire projects. Research by Müller and Siebenhüner (2007, p.242) indicates that "*The* *particular challenges of sustainable development will require a combination of directive and more reflective instruments. While basic ecological standards can and should be monitored and sanctioned in a conventional command-and-control fashion, further advancements of corporations towards social and ecological objectives might better be achieved by persuasive and cooperative approaches*."

To this I add that the development of this kind of participative, collective learning system with joint decision-making can be the result of a learning process that includes practical societal experiments. The direction of development that is suggested here touches government investments in innovation in the private sector that are already actual and that warrant societal influence, according to Mazzucato (2012a): *"First, innovation is collective – involving different types of firms, financial agents, and government institutions. It is also uncertain – with high failure rates but also high returns, with the state often undertaking the greatest degree of risk and uncertainty. And third, it is cumulative innovation today that builds on innovation yesterday. This means that particular agents have been able to "position" themselves strategically along the innovation curve and reap the returns under the entire area rather than just their marginal contribution. (…) To end this parasitic situation, it is important to think creatively how the returns from state investments can be retained to benefit the public that has funded them, and be reinvested in the next round to generate more.* And (Mazzucato, 2012b) *"While infrastructure projects are important for employment in the short run, they do not provide the vision for change needed to transform European economies so they can face future technological, environmental and economic challenges. Indeed, the countries that are growing at double digit rates are not only spending, but also have ambitious visions for the direction of public investment."*

However, as Nooteboom proposes when promoting multi-actor systems for learning and innovation, "*Another point that is important for policy concerns trade-offs between variety and homogeneity and between stability and change. Variety, in numbers and cognitive distance, is beneficial for radical innovation, but a certain homogeneity and cognitive proximity is beneficial for collaboration. Hence one should make trade-offs and look for optimal variety and distance. Similarly, a certain flexibility and variability of relations is needed for innovation, but also a certain stability, to elicit and enable investments in mutual understanding and trust. Hence one should make trade-offs here as well, in looking for optimal rather than maximal flexibility"* (Nooteboom, 2006, p.16).

9.5.5 Management capabilities

The finding in this research regarding the positive effect on innovation of a management style that focuses on open communication and participation is supported by the finding of Høyrup (2012) that openness in organizations and autonomy in work are important for the creation of diverse learning systems, variety and divergent, innovative learning processes. It is also in accordance with the conclusion of Siebenhüner and Arnold (2007, p.348) that a participatory style of leadership enables the "*(…) generation of new knowledge, as well as its transfer and diffusion",* and with the finding of Dasgupta and Gupta (2009, p.215, referring to Jong and Hartog, 2007) that *"An efficient leader, in order to encourage employees to provide new ideas and to implement them, should not only serve as a role model for the subordinates but also communicate an explicit vision of innovation, give subordinates sufficient autonomy to determine independently how to do a job, be supportive an a subordinates' quest for innovation, provide feedbacks to employees and show appreciation for innovative performances."* The positive effects on the quality of decision-making of the freedom of actors to communicate and collaborate was already recognized by Beer (1972): *"(…) this management group will (as a whole) hardly ever make a mistake – as long as its members really collaborate*" (p.260). And "*Our search paradigm must be priority-free*" (p.264).

Muff et al (2013a, p.27) confirm the identified need to develop management capabilities "*…to embrace complex transdisciplinary issues and hands-on collaboration with other members of the larger community*" and "*…to treat the human being, the organization and society as an open, emergent and dynamic system that progresses (and can regress)…"* The DLE case study illustrates Heugens' (2007) finding that CSR activities under certain circumstances may contribute to legitimacy destruction, and that mitigating this risk demands the development of specific management, communicative and cooperative capabilities.

My research found that the observation of concrete issues, not only moral or ethical considerations, stimulated the processes of innovation. Reconstructions of the histories and different aspects of the societal and company issues were an important part of problem and concept development. These reconstructions enabled managers and specialists to gain a deeper understanding of the issues and their origins, and this understanding provided the basis for fruitful ideas. The learning and innovative power of reconstructing work practices and experiences in social settings is recognized by Høyrup (2012), Hargadon (2003), Price (2012) and Rivkin and Taylor (1999). The reconstructions in three of the four projects studied in this research demonstrated that the envisioned improvements consisted of interdependent product and process innovations, and led to the insight among the actors that a renewal of work processes and organizational structures was needed to make the innovations possible, which is in line with the findings of Frishammar et al (2012). These renewal efforts, in turn, uncovered new issues and led to new reconstruction activities.

This research agrees with the findings of Nooteboom (2009, p.122) that in or between organizations the abilities to achieve sufficient stability, mutual understanding and willingness to collaborate are important "(…) *for the sake of exploitation, while allowing for variety of knowledge and autonomy and spirit of competition, for the sake of exploration*".

My findings on the networking activities of managers in the four projects are similar to the findings of Westerlund and Rajala (2010) that exploitative learning orientation promotes process innovations but not networking, and that an explorative orientation promotes product innovation and networking. Moreover, networking and inter-organizational collaboration in the projects studied in this research led to the recombination of knowledge, ideas and insights and to new and common understandings and meaning. This is in accordance with the processes described by Hargadon (2003). The importance of observation and networking capabilities is also proposed by Deephouse and Heugens (2009), specifically in helping a company to decide whether to adopt an issue or not.

9.5.6 The development of management capabilities

Regarding the question of how to develop capabilities that facilitate organizational learning and innovation, this research endorses the conclusion of Siebenhüner and Arnold (2007, p.350) that *"(…) qualification and training of personnel seem to be most helpful for enabling organizations to learning and change."* The observation of "*…a remarkable difference in content between capabilities that are built through cooperative relations and those that are initiated in an adversarial context"* (Heugens, 2003) is supported by my research. And Wu et al (2012) stress the importance of systematic management routines to effectively develop and deploy dynamic capabilities. The importance of working on concrete issues and projects that I found, is supported by Høyrup (2012, p.17): "*Learning is both a response to innovative processes and an inspiration for innovative processes of the firm",* and by Muff et al (2013a).

Garcia-Morales et al (2006, p.24) stress that attention to personal mastery *" the fine art of managing your mind and the desire to understand and learn for its own sake -"* supports organizational learning, because it helps people "*(…) to clarify and improve their personal vision".* Admiraal-Hilgeman and Geurts (2011) emphasize the importance of connecting personal development with the passions of employees in education. However, no author specifies how a link between individual, personal interests and development choices and team or organizational development may be brought about and managed systematically.

Nooteboom (2009, p.122) emphasizes that organization-specific capabilities start from "(…) *the imprint of a founding entrepreneur, rooted in deep level cognitive categories* (…).' However, Nooteboom does not specify a distinction between skills and methods, and only mentions "*cognitive focus*". Muff et al (2013a, p.27) emphasize "…*whole person learning*...", personal development, organized around societal, environmental and economic issues and accompanied by guided reflection.

My research tends to support the view of Heugens et al (2004) that an organizational capability is influenced by decision rules. But it also suggests that the usefulness of these rules can be limited or even counterproductive in new situations. Depending on the underlying learning and innovation philosophy of management, they may be developed further, or not, in order to more effectively structure organizational responses to changing circumstances.

Research by Argote and Miron-Spektor (2011) finds that there is no clear evidence regarding the link between diverse and deep experience of managers and their creativity. However, this research finds that the contribution of more senior, experienced managers seems to have facilitated project success via contributions to problem and concept development and design and implementation. My findings are comparable with the finding in case study research by Narayanan et al (2009) that senior managers played an important role in capability development through their cognitive orientations, confronting of political challenges, resource allocation, traditional management roles, path finding and negotiating resistance. Differences in outcomes between studies may be explained by the effect uncovered by Jansen et al (2011, p.207) *"… that higher experience levels and greater breadth of social capital can be an asset or liability, depending on the topic of decision and the involved parties for implementing that decision."*

The innovation processes studied in this research have not or have only been partly guided by external consultants. In all instances, only managers from Companies A, B and C intervened in order to direct change processes. Research by Geurts, Altena and Geluk (2007, p.330-334) presents an evaluation of eleven basic principles that would underlie effective interventions. Some of these principles are confirmed by my research: Social system change can be orderly and effective if all actors are involved, and if there is mutual coordination between the different hierarchical levels. Management should strive for openness and common understanding. Learning takes place effectively in relation to concrete issues and projects. Change involves collective action within the larger organization. Existing power balances play a limiting role. And interventions should be regarded in the light of longer-term project and personal and organizational development paths. However, with respect to some principles, my research presents different findings: The principle of simplicity does not recognize the value of accepting and trying to understand the complexity of messy or wicked issues. And, conflicts may arise, but they may methodically play a role in creating a setting for new insights or new combinations of ideas. Furthermore, my research paints a picture of how to achieve in practice *"(…) interaction or collective quest and for communal learning"* (principle 8) and how people may be helped *"(…) to look beyond the boundaries of their own capabilities and knowledge"* (principle 9). Indeed, the qualities of managers, consultants and other people play a crucial role in the effectiveness of interventions, and my research indicates how these qualities and mutual trust can systematically be enhanced in the change process itself to develop organizational capability.

9.5.7 Dynamic capabilities for innovation and sustainable development

The existence of a relationship between the level of dynamic capabilities and the level of innovation and sustainable development is referred to by several scholars. Castiaux (2012) suggests that "*The more a firm integrates environmental considerations in its strategy, the more existing competences and resources, but also dynamic capabilities, are questioned*. (…) *In particular, firms have to develop competencies to open* [up - HvK] *to stakeholders* (…)" (p.15). This finding is confirmed by the cases in this research.

In a similar line of reasoning, Ednilson de Oliveira (2010) and Klewitz and Hansen (2011) propose that the level of innovation on sustainability may be related to the types of innovations realized, and that these are influenced by the level of dynamic capabilities that a company has developed or by the involved actors and mechanisms of influence. These studies confirm the finding of my research that the development of capabilities for Inter-Organizational Learning System Development is crucial.

The management capabilities that this research identified are related to the dynamic capabilities mentioned by Frishammar et al (2012, p.526) that enable the adaptation and transformation of other capabilities, such as a process innovation capability. Nooteboom (2009) identifies two levels of dynamic capabilities, on the level of individuals and organizations, plus the ability to employ a heuristic of invention for developing exploitation into exploration. And Wu et al (2012, p.242) present a model with three aspects of dynamic capability (scanning, identification and reconfiguration). However, these models show final, ideal situations and they maintain a high-level view. They do not show linkages with the demanded development of the supporting organizational aspects and management capabilities that my research found to be important. The same holds for the model by Ramachandran (2011, p.288) and the conclusions of Kaefer and Salchenberger (2013).

In that sense, the parallel development trajectories shown in the model that this research creates forms a new addition to theory, in concordance with the advice of Wang and Ahmed (2007", p.44) that "(…) *the change trajectory in the external environment, the firm's historical and current strengths and weaknesses, its long-term strategic orientation and its product-market positioning must be considered simultaneously in order to channel its resources effectively toward capability development*." This newness is also indicated by the fact that, in terms of characterizations developed by Di Stefano et al (2010), the findings in my research are in the fields of governance structure and transformation processes and entrepreneurship, fields that in relation to dynamic capabilities are less populated by scholars than other ones. The findings of this research contribute an answer to the call by Barreto (2010, p.277) for "(…) *a consolidation of the main construct and a capitalization on previous research in a more structured, focused way*." And also to the need expressed by Easterby-Smith et al (2009, p.7) to study the dynamic nature of capabilities.

9.6 Concluding remarks

On the basis of the analysis and cross-case analyses in chapters 7 and 8, in this chapter I answered research questions 1, 2 and 3.

I found that the processes of learning for innovation in two projects contributed to the development of changes for greater sustainable development. These outcomes were realized by managers mainly through the improvement of inter-organizational learning systems and, to a lesser degree, through their participation in innovation processes. Most effective in the management efforts were a focus on communication for common understanding, joint decision-making, participation in a wide range of innovation processes, and facilitation of processes of social reconstruction of issues and construction of innovations. A sustainability philosophy and systems view with experienced, senior managers helped to identify internal and external actors from economic, social and environmental networks who were related to the issues, and to prevent the escalation of tensions. Managers in all projects applied technical capabilities, methods and philosophies that allowed them to understand and partake in the innovation processes. If the applied capabilities, methods and philosophies for innovation and learning system development complemented each other on a team level, they then gained in effectiveness.

In section 9.3.2, I developed a conceptual model of the dynamics of inter-organizational learning for innovation. The model shows how the developments of all three Aggregate Aspects are mutually related in logical ways. The model forms the basis for theoretic propositions in chapter 10 and provides a tool for practitioners to analyze and improve the innovation projects that they are working on. In section 9.3.3, I argued how the development of dynamic capability in the model overlaps with the combined development of innovation processes, inter-organizational learning systems and innovation and learning capabilities. Section 9.4 shows how this research answers the critical observations that were described in sections 3.2 and 3.3.

In the Discussion in section 9.5, the answers from the research questions were related to the findings of other scholars. It became clear that my research differs in several aspects: Firstly, unlike other scholars that I studied, I have modeled the dynamics of the main aspects that influenced the development of (inter-)organizational learning and innovation processes, including their interrelationships. This has been done in a way that suggests ways in which to *systematically* picture, preview and manage the empirical development of a concrete inter-organizational innovation project and of a dynamic capability for innovation for sustainable development. Secondly, I did not find any other research that, like my own research, clarifies how the development of management contributions and capabilities is related to the development of learning structures and innovation processes. Thirdly, only a few of the scholars I studied also refer to factors that influence or stimulate the development of management capabilities, and those who mention the subject do so only in general terms. In the fourth place, few scholars mention the negative influence that the presence of a dominant interest exerts on the quality of organizational learning, and other research only implicitly suggests the need for more participative business models. And finally, my research contributes insights and methodical suggestions for dealing systematically with concrete, empirical wicked problems, messes, and domain-related meta-problems. My findings are supported by authors who laid the foundations for the concept of systems change and sustainable development in the 1960s and 1970s.

In chapter 10, the research is rounded off with conclusions that consist of theoretical propositions and recommendations for researchers and practitioners. Also, a reflection on the research is presented.

10 Conclusions. Theoretical propositions and recommendations

10.1 Introduction

In chapter 1, I formulated the need for this research. The defined aim was to increase our understanding of learning as part of innovation for sustainable development, in order to contribute to innovation in the way business innovates and to help our society move faster towards more sustainable development.

In chapter 2, I defined the main terms that I use. I showed the links between innovation, organizational learning, competence and dynamic capability. Then, in chapter 3, I presented literature research aimed at exploring research related to innovation capabilities, sustainable development, innovation, organizational learning and dynamic capabilities. This resulted in four critical observations that formed the basis of a research agenda and three main research questions. In chapter 4, I explained the research method and philosophy, and the history of the paper and board producing sector in The Netherlands was described in the introduction to chapter 5. In chapter 6, the specific projects and companies were described. An analysis was carried out in chapter 7 in order to structure the multitude of interview data and compare their qualities, and in chapter 8 cross-case analyzes were performed. This resulted in insights into the aspects that defined the learning processes, the influential factors and developments of these aspects, and the dynamics between them. With these insights I was able to specify the activities, capabilities, methods and philosophies that had contributed to wider learning and greater management satisfaction in the projects. I answered the research questions in chapter 9. I developed a conceptual model of the dynamics of inter-organizational learning for innovation and discussed how this research answers the critical observations identified in chapter 3. In the Discussion in chapter 9 this research was mirrored to the findings of other scholars, showing its new contributions.

In chapter 10, the research is rounded off with theoretical propositions and recommendations (section 10.2) that are logically grounded in the conceptual model (figure 9.5) and in the characteristics of the Aggregate Aspects that had contributed to wider learning and greater management satisfaction in the projects (Table 8.6). These four propositions are interlinked. They are brought forward under the condition stated in chapter 4: *Generalization of the outcomes of the research to other projects or companies is only possible after* *analysis has demonstrated that the aspects, influential factors and developments in these projects are comparable with the ones brought forward in this research.* The theoretical propositions also serve as intellectual stimuli for further research by scholars and practitioners. Further reflection on the research is presented in 10.4.

10.2 Theoretical propositions

I conclude that the width of learning that was realized in the projects was influenced mainly by: 1) the opportunities that are available for the actors to develop new options; and 2) the diversity in the inter-organizational learning system. Also important were: 3) the method by which issues are approached; and 4) the seniority and capabilities, and methods and philosophies of the involved managers.

Points 1 and 2 were brought to light by the two situations that can be distinguished in the cases where societal issues played a role.

First, in the DLE case, the Provincial environmental authorities ruled that the 'Best Available Technology' had to be applied. Because the emission regulations were clear and were enforced, there was no room in the discussions between company C and the Provincial environmental authorities to develop an innovative solution. Company C was forced to innovate not so much with regard to its production process or products, but in its organization and project management capabilities in order to succeed in implementing the prescribed technology. In this process, learning took place with all actors except the Provincial authorities.

In the second situation, the Rofire case, the pressure to improve originated from financial environmental instruments: the dumping of waste would gradually become more expensive. This left company A the freedom to choose between different options. For example, it could stick to the old situation and pay the higher prices; it could try to save money elsewhere; or it could try to diminish or prevent the waste stream and prevent rising costs in the future.

Company A needed to maintain its efficiency, so paying the higher dumping prices was not a satisfactory solution. But because the inter-organizational learning system of company A was extended with the Subcoal group, new ideas and knowledge on ways to deal with waste became feasible. As a result, the situation that developed was characterized by: 1) The absence of a dominant actor that forces a solution, and a certain freedom of choice for company A and other actors in how to approach the company and societal issue;

and 2) the development of an extended inter-organizational learning system with actors from the economic, social and ecological networks who contributed new perspectives, ideas, knowledge and experience. Because of these circumstances, in the Rofire case a discussion was allowed to develop in which a social reconstruction of the issues could take place, a common understanding among the actors was developed, and an innovative solution was constructed socially. Thus, learning took place among all actors and networks.

The following propositions represent the main theory regarding the three identified Aggregate Aspects that flows forth from this research. They apply to learning to learn for innovation and sustainable development in situations with societal issues that are messy (Ackoff, 1974) or wicked (Rittel and Webber, 1972) where no clear legal regulations apply for enforcing solutions, where a certain freedom of choice regarding the development direction exists, and where knowledge concerning the most effective direction is not conclusive.

Proposition 1 relates to innovation processes and the inter-organizational learning system.

1. *Learning for innovation and sustainable development, and also levels of management satisfaction, are improved when a team consists of actors from the economic, social and ecological networks and when it:*

1.a Invests in learning from the past

A focus by actors from the economic, social and ecological networks on a social reconstruction of the histories and backgrounds of issues promotes insight into the roots of issues and builds common understanding in a team. Thus, a basis is developed for the social construction of goals that are appropriate, understood and accepted, and of innovations that contribute to sustainable development.

1b Applies joint decision-making

The participation in a learning system of actors from the social and ecological networks, with interests, cultures and views that differ from those of economic actors, highlights the hidden aspects of various issues. This naturally promotes discussions and arguments that tend to block the sharing and recombining of ideas, knowledge and experience if one actor is dominant and tries to enforce a decision. Joint decision-making procedures stimulate actors to continue the discussions and to keep contributing to a project. This results in deeper and wider learning, a better fit between innovations and issues, and greater management *satisfaction than in the case of a less diverse learning system in which decisions are forced upon actors.*

The second proposition looks at innovation and learning capabilities.

2. <u>*The potential for learning, innovation and management satisfaction increases if teams are guided by experienced, senior managers with specific strengths in inter-organizational learning system development*</u>
The diversity of the actors and the quality of the meetings that form the structures of inter-organizational learning systems in which they meet, argue, discuss, cooperate and learn define the potential for management satisfaction and learning. The guidance provided by experienced senior managers with specific capabilities, methods and philosophies in the fields of systems thinking, networking, communication and development improves this quality.

The third and final proposition highlights aspects of the practical development of a competence of learning for innovation and sustainable development.

3. <u>*Enduring practice needs to accompany the study of theory on learning for innovation and sustainable development if an organization wishes to develop the related organizational competence*</u>
Enduring practice with other actors in concrete projects is necessary in order to learn how to develop and manage a diverse learning system with joint decision-making, and how to sufficiently reconstruct complex issues and build common understanding. Practice in dealing with the complexity of social issues and the dynamics of the different aspects of innovation projects, accompanied by properly guided reflection, helps to improve and systematize inter-organizational learning for innovation and sustainable development and to build the related organizational competence.

These conclusions are explained below.

Ad 1a <u>*Learning for innovation and sustainable development, and also levels of management satisfaction, are improved when a team consists of actors from the economic, social and ecological networks and when it invests in learning from the past*</u>

A focus by actors from the economic, social and ecological networks on a social reconstruction of the histories and backgrounds of issues promotes insight into the roots of issues and builds common understanding in a team. Thus, a basis is developed for the social construction of goals that are appropriate, understood and accepted, and of innovations that contribute to sustainable development.

In an inter-organizational learning system, the social reconstruction of the backgrounds and histories of issues from economic, ecological and social perspectives builds knowledge of the roots of these issues. It provides insights into the philosophies, work methods and behavioral patterns that underlie persistent messy and wicked problems. Such understanding contributes to the generation of new insights and ideas about potentially promising directions of development. At the same time, the actors, if they perform the reconstruction together, increase their common understanding of the issue and of each other. This enables and focuses the autonomous actions of the actors and improves cooperation in innovation processes. The social reconstruction of issues stimulates the design of goals and measures that fit the origins of issues and that are understood and accepted by actors.

Therefore, management in an inter-organizational learning system should design meeting structures that facilitate the reconstruction of issues, the creation of common understanding among the actors, and the prevention of escalation of tensions that accompany reconstructions that some actors may find undesirable. In terms of achieving these aims, joint decision-making procedures are indispensable.

Ad 1b *<u>Learning for innovation and sustainable development, and also levels of management satisfaction, are improved when a team consists of actors from the economic, social and ecological networks and when it applies joint decision-making</u>*

The participation in a learning system of actors from the social and ecological networks, with interests, cultures and views that differ from those of economic actors, highlights the hidden aspects of various issues. This naturally promotes discussions and arguments that tend to block the sharing and recombining of ideas, knowledge and experience if one actor is dominant and tries to enforce a decision. Joint decision-making procedures stimulate actors to continue the discussions and to keep contributing to a project. This results in deeper and wider learning, a *better fit between innovations and issues, and greater management satisfaction than in the case of a less diverse learning system in which decisions are forced upon actors.*

It is important to highlight the ecological and social aspects of issues and interests that remain hidden when only actors from economic networks, with a limited view, knowledge and experience, populate a learning system. Through this process of opening up, the empirical complexity of issues can be revealed so that research and other innovation processes can be adapted to it.

However, clarifying the hidden sides of issues often provokes discussions and arguments between actors. This is a natural phenomenon, but one that nevertheless needs to be checked in order to prevent the exchange of information, ideas and knowledge from being inhibited and interests from being suppressed, and to allow tensions to become productive.

If the actors know that, because of formal joint decision-making procedures, their contribution can make a difference in the course and the outcomes of a project, they will be more willing to deliver a meaningful contribution and to continue doing so when disagreements arise. Thus, joint decision-making procedures stimulate deeper research and the reconstruction of issues. They encourage the expression of existing experience, knowledge and ideas, and thus enable the emergence of new combinations therein. Learning processes that form the basis for the development of innovative solutions and organizational competences are intensified. Thus, a diverse learning system with joint decision-making is able to generate innovations that fit complex, messy or wicked issues much better than a less diverse system with a dominant actor does. Therefore, the domination of a learning system by one interest should be avoided, also because it hinders learning by the dominant actor.

Joint decision-making may conflict with the view that the power to make decisions that concern a company is a prerogative of the owners of the company and of the management that represents them. However, this power is already limited by numerous legal regulations, and the concept of joint decision-making is a further development of this situation on the basis of increased insight into what is needed to resolve societal issues that threaten life on earth. It is based on the insight that other actors have also invested in the company, albeit not financially, e.g. in the form of time, energy or ideas, as stated by Ackoff

(1974, p.63): *"All the participants and those affected by it invest some type of resource (including themselves) in it. Why should the stockholder be singled out and be permitted to dictate corporate objectives? (…) The average employee probably has more to lose by his employing corporation going out of business than does the average stockholder."*

Joint decision-making also conflicts with the conventional view in economics that actors follow their self-interest. Seen from this perspective it is very difficult to jointly choose a direction of development that satisfies common needs over individual ones. However, it has been found that people also make decisions based on identity (Heath and Heath, 2010, p190): *"They ask themselves three questions: Who am I? What kind of situation is this? And what do people like me do in this kind of situation? (…) There are no calculations, only norms and principles."*

Creating a diverse inter-organizational learning system with joint decision-making should be part of the formal policies of any company that wishes to innovate and contribute to greater sustainable development. Extending the diversity of an organizational learning system can be facilitated by drawing up an inventory of the economic, ecological and social aspects of an issue.

Ad 2. *<u>The potential for learning, innovation and management satisfaction increases if teams are guided by experienced, senior managers with specific strengths in inter-organizational learning system development</u>*

The diversity of the actors and the quality of the meetings that form the structures of inter-organizational learning systems in which they meet, argue, discuss, cooperate and learn define the potential for management satisfaction and learning. The guidance provided by experienced senior managers with specific capabilities, methods and philosophies in the fields of systems thinking, networking, communication and development improves this quality.

Managers must have already developed some specific capabilities, methods and philosophies with regard to inter-organizational learning system development in order to be able to increase the potential for management satisfaction, learning, innovation and sustainable development in a project. These include: a systems view that acknowledges the complexity and the different economic, social and environmental sides of issues, plus the related networks; networking, communication and organizational capabilities to invite actors from different networks into a learning system and build working relationships; and communication and joint decision-making capabilities to stimulate the reconstruction of issues, promote common understanding, prevent the escalation of the tensions, and to employ tensions as stimuli for deeper research and wider learning. In other words, an innovation philosophy that acknowledges the need for organizational learning and in-depth knowledge of the issues, the phases of innovation processes, and of the related business processes, policies and work methods.

Through their life and work experience, senior managers are more likely than younger managers to have developed and integrated the required capabilities, methods and philosophies. Managers can be trained to guide teams in the development of an organizational competence for innovation and sustainable development. Explicit attention to their characters, cultures, work experiences and formal educations strengthens their professional development.

Ad 3 *<u>Enduring practice needs to accompany the study of theory on learning for innovation and sustainable development, if an organization wants to develop the related organizational competence</u>*

Enduring practice with other actors in concrete projects is necessary in order to learn how to develop and manage a dynamic, diverse learning system with joint decision-making, and how to sufficiently reconstruct complex issues and build common understanding. Practice in dealing with the complexity of social issues and the dynamics of the different aspects of innovation projects, accompanied by properly guided reflection, helps to improve and systematize inter-organizational learning for innovation and sustainable development and to build the related organizational competence.

This conclusion is important as too often theoretical understanding is believed to be sufficient to be able to improve business practices. This belief neglects the complexity of sustainable development issues and the dynamics and developments of the different aspects of innovation projects in practice, and it contributes to plans and approaches that are not effective.

The study of theory alone is not sufficient to develop a competence of learning for innovation and sustainable development. The development of this competence entails a new journey in learning and development: companies and other actors need to learn how to learn with others and from the past. It takes time and practical experiences in messy, daily practice to develop insights and trust in the dynamic, multi-sided learning processes for innovation and sustainable development. Self-discipline and careful reflection are needed to learn to deal with arguments and tensions in a positive way and to trust their logic and usefulness. And patience must be cultivated to persist through the ups and downs, to deal with complex issues and insecurity, to develop trust among the actors, and to gradually develop a new innovation culture together.

The integration and alignment of management theories and practices for innovation and sustainable development into organizational competencies is facilitated by team coaching in relation to actual issues and projects. Competence development requires a learning system that predominantly uses regular formal (inter-)organizational meeting structures that develop in accordance with the needs of the innovation processes. Formal meetings and procedures help to anchor their outcomes. The composition of the membership and the prevailing rules and procedures for these meetings determine whether discussions and arguments support or limit innovation and competence development. Informal meetings are also useful, as they stimulate open communication and the disclosure and recombination of knowledge and ideas.

10.3 Suggestions for further research

Complexity

Further research could focus on the level of awareness of managers of the complexities and various aspects of innovation projects in a larger number of cases than has been examined in this research. From which perspective do managers approach innovation projects in practice? Which aspects do managers take into account? Why these particular aspects? How do they deal, in practical terms, with the complexity of issues and how have they learned to do this? What is the relationship between their approach and the teamwork, the applied capabilities, methods and philosophies, the processes of learning and innovation, and the outcomes of the projects?

Learning systems

Further research could focus on the learning systems in a larger number of innovation projects in which actors from economic, ecological and social networks participate. A broader knowledge base could be constructed on the conditions that hinder and promote the reconstruction of the backgrounds of issues, common understanding and joint decision-making among culturally different actors. Inter-organizational learning is connected to the subject of societal learning.

It would be interesting, for example, to examine how the powers are distributed among the actors in different projects, and whether one interest is dominant; if cognitive distance between the actors exists and to what extent and with which methods efforts are made to reach a common understanding; in which way decisions are taken, if joint decision-making plays a role, and how business models can be realized in which joint decision-making takes place. It would be interesting to study what the relationships of these findings are with the functioning of the learning system, with the processes of learning and innovation between actors and on a societal level, and with the satisfaction of the actors with regard to the outcomes of the projects. This research could be connected to theories on leadership, networks and stakeholders.

Capabilities, methods and philosophies

Given the crucial role that complementary capabilities, methods and philosophies play in the realization and quality of learning and innovation processes, further research could endeavor to improve the insights gained from this research and to find answers to the following questions in relation to innovation projects that aim to contribute to sustainable development. Which dominant capabilities, methods and philosophies have played a role? How have they been developed? To what extent are they complementary? Have they been consciously applied, and can they be distinguished as the characteristics of a team? How have the teams been composed? To what extent has this been done consciously from the perspective of a desired complementarity of capabilities?

Organizational competences

In the future, many companies are likely to be confronted with the limitations of ecological and social systems. It is to be expected that companies that have developed the competence to improve and innovate, not in an accidental but in a systematic way, will have the best chances with regard to the continuity of their business. It would therefore be interesting to examine the extent to which companies are aware of their competences and if and how these relate to innovation and sustainable development. Research could focus on how companies have developed their competences, find out how systematic their efforts are and whether or not they follow a team-based approach, and discover the management development methods applied to realize this.

10.4 Recommendations

On the basis of the conclusions in the previous section, the following recommendations for pragmatic action are presented:

Recommendations for company managers

Based on propositions 1 - 4 above, the recommendations for managers who work on innovation projects that are meant to contribute to sustainable development are to:

1. Accept that an issue is complex, that a mess is a mess, and that a wicked problem is wicked. Do not try to simplify it. Acknowledge that complexity has to be dealt with in order to generate effective solutions. Acknowledge that theoretically ignoring complexity does not change the difficulties of an issue in reality. Accept that the resolution of new and complex sustainability issues through innovation demands time-consuming inter-organizational learning processes that have their own unpredictable dynamics and outcomes.

2. Research and take stock of the economic, ecological and social aspects of the issue together with the other actors involved with the issue. Reconstruct its history until its underlying origins, dynamics and logic are understood sufficiently. Deep common understanding of an issue and its development is the best base for the construction of suitable innovations.

3. Evaluate the learning system and the actors involved. Do all actors related to the issue participate? Are the economic, ecological and social aspects of the issue represented by actors? Do the rules governing the decision-making of the platforms facilitate joint decision-making? If not, engage in networking and actor involvement to improve the learning system. Adapt the rules to facilitate greater participation, contributions and learning.

4. Evaluate the philosophy, methods and capabilities applied by the team managing the resolution of the issue. Check the following: Do the team members work from a learning perspective? Are the participants equipped with the capabilities, methods and philosophies required to network with culturally diverse actors, to involve them and to facilitate communication for common understanding within the learning system? Are they equipped to prevent the escalation of frictions and arguments? Can they handle joint decision-making processes with these actors and deal with situations in which their interests are not dominant? Are they equipped to reconstruct an issue and take stock of its multiple aspects and dynamics, together with the other actors? And are they equipped to overview and understand the different phases and needs of innovation processes, and adapt the learning systems accordingly? Are they able to formalize the outcomes of innovation processes in the policies and working methods of the company? Organize a team coaching and management development program in the running project whose focus is on developing these philosophies, methods and capabilities. Educate experienced senior managers to function as team coaches.

Recommendations for policy makers

Policy makers are confronted with the challenge of finding solutions for messy, wicked, societal issues related to sustainable development. These issues are characterized by long-term effects and diverse (economic, ecological, social) aspects, by the involvement of many and culturally diverse actors with conflicting short-term interests, and by a lack of knowledge, overview and predictability.

Using only moral or ethical appeals has proven to be ineffective in involving companies on a large scale and in stimulating innovation processes. This research suggests that as long as the formal decision structures of companies have a non-participative character and are dominated by mainly economic interests, and to the extent that companies are not legally obliged to submit their innovations to democratic decision structures and regulation, it cannot be expected that innovation that contributes to greater sustainable development will make any great advances. If governments wish to stimulate a significantly larger number of companies to engage in learning how to innovate and contribute to solving societal issues, I recommend that they focus on translating these issues into issues directly related to those companies and the systems they employ. To this end, I recommend three approaches:

1. As Mazzucato (2012a, 2012b) advises, governments may act as a participant in innovation projects with businesses, and in that role demand attention for societal issues, long-term and system perspectives, and introduce criteria for sustainable development. This would imply a new rationale behind the concept of public-private partnerships. The growing involvement of governments in the financial sector, with the aim of repairing and preventing unsustainable practices, illustrates this approach.

2. Governments may create formal platforms as bases for inter-organizational or societal learning systems and use these to bring together in processes of learning and innovation the actors who are involved in specific sustainability issues. An example is the Search Conference (Emery and Purser, 1996).

In order to be able to apply these two approaches and elicit the willing cooperation of other actors, governments also need to build the philosophy, methods and capabilities mentioned in recommendation 3 above. Government representatives must learn to analyze and reconstruct issues together with a team; to communicate in informal meetings and formal platforms to create common understanding with culturally diverse actors; to prevent the escalation of arguments; to guide groups in a participative way with joint decision-making; and to develop an orientation that focuses more on team-learning processes than it does on goals.

3. And thirdly, governments can design laws and rules that create the conditions that challenge businesses to innovate in new ways that will contribute to system change towards greater sustainable development. However, this approach brings with it the danger that learning and creativity in companies will focus not on improving sustainability but rather on circumventing the law or on merely formally satisfying the rules. It also does not stimulate governments to participate in the learning process, with the result that societal learning does not take place.

10.5 Reflection on the research method

In this section I evaluate the applied qualitative research method, which consisted of a combined inductive and deductive approach, against a number of criteria. I will answer the following questions.

- Neutrality: Was the research sufficiently neutral, or was it biased in such a way that the outcomes cannot be trusted?
- Data integrity: Did the method of data collection and storage guarantee data integrity during the research process?
- Authenticity, confirmability and validity: Is the data authentic, valid and can it be confirmed?
- Auditability: Are the steps in the research process auditable?
- Transferability: Can the outcomes be transferred to other situations?
- Applicability: Has the research generated outcomes that are applicable in practice?

At the end of the section I will summarize the findings.

Neutrality
Ever since his younger years, the researcher has been interested in the workings and beauty of nature. He values nature highly and abhors the ongoing degradation of the natural environment. This disposition has stimulated him to develop his profession as a consultant for sustainable entrepreneurship. A particularly successful stakeholder dialogue and innovation project to which he contributed formed the initial stimulus for this research. Therefore, the researcher was biased in that he finds it important that new and more sustainable ways of doing business are developed, and that on the basis of his experience he is convinced that these ways can be found and applied. Furthermore, his experience with company projects in the areas of innovation, environmental management, sustainability and stakeholder dialogue has naturally shaped his observation, intuition, research and synthesizing capabilities.

I think that in cooperation with my Promotor I have managed to limit the influence of this bias in two ways. First, by basing the problem description, the identified critical observations and the research questions on extensive literature research so that the research is supported not so much by personal observations but rather those of broader communities. And secondly, by asking the interviewees open, semi-structured questions that did not mention the words environment, sustainable or sustainability and did not hint at those subjects. In this way, my bias has not stimulated the interviewees to answer in a socially acceptable way. Also, staying close to the actual interview data in the processes of analysis and synthesis and making use of quotations have helped to prevent researcher bias from becoming overly influential.

Data integrity

All but two interviews were recorded on tape and transcribed verbatim. All files related to the case studies were stored under the name of the study and back-ups were made. There has not been any need to use the back-ups. The tapes with interviews and the transcriptions are available for peer review. Each quotation can be traced back to the interviewee and the specific context via the transcriptions and tapes.

Data authenticity, confirmability and validity

The use of semi-structured, open questions without a moral component stimulated the interviewees to tell their own stories and stay close to their experiences. My experience as a consultant with the narrative interview technique helped me to stay silent as much as possible during the interviews, to not interfere with the answers of the interviewees, and to not introduce my interpretations or examples in the story. In this way the interview data has retained its authenticity.

Using the snowballing technique, in each case study I interviewed the main actors, all of whom presented somewhat different perspectives on the projects. Most interviewees added some data that interviewees before them had not mentioned, but the last interviewees usually did not. This showed me that the saturation point of the data had been reached and that a complete picture of the project could be constructed.

By interviewing the main actors in the projects, different perspectives on the courses of events have come to light. The narratives also revealed some disagreements and conflicts, and it became clear what role they played in the projects. I think the risk that only the dominant and socially accepted logic of the projects was conveyed through the interviews, which I described in chapter 4, has been diminished sufficiently.

In the research, I have made extensive use of quotations from interviewees, taken from the transcriptions. The quotations provide examples and evidence of the course of events in each project, of the different aspects that played a role in the innovation processes, and of the interrelationships and dynamics within and between these aspects.

In each case study, the data collected on the project were consistent with each other and could be formed into a thick description. All thick descriptions were sent for inspection to the project managers and, apart from a few minor changes, the stories were accepted as valid and accurate. The thick descriptions and the comments of the managers are available for peer review.

On the basis of this evaluation I conclude that data authenticity, confirmability and validity have been guaranteed.

Auditability

I have made the research process transparent by providing detailed data and by explaining each step in the process.

It was my intention at the beginning of the research to use Atlas-ti software to code and order the interview data and to discover relationships. I tried to do this with the first case study, but found that the amount of data was too large and too rich, and that the number of codes exploded. I then decided to first develop a lens through which to examine the data to provide a first rough order. I have done this in section 3.7, where the main aspects of multi-actor innovation projects were distinguished. Chapter 7 explains the development of First Order Concepts and the Second Order Themes and Aggregate Aspects on the basis of the interview data. All steps in the cross-case analyzes have been explained in chapter 8, with an overview of the data used. All the data can be traced back to the contributions of the actors in the projects, as reported by the interviewees. The steps used for the synthesis into the conceptual model were explained in chapter 9. Looking at the different steps in my research, I conclude that the research process is completely auditable.

Transferability

The research has resulted in a rich understanding of each separate project and of the different aspects and dynamics that were common to the projects. The model that was developed in section 9.3 is applicable to the four cases. It has been the intention of this research to develop deep theoretical and methodical understanding of a number of different innovation projects. This has resulted in a number of theoretical propositions to stimulate and support the development of new inter-organizational learning approaches for innovation and sustainable development with practitioners and researchers. Because of the methodical nature of the propositions, I think that they can at the very least support efforts to improve applied innovation methods for greater sustainable development in other projects in companies in the same sector or in other sectors.

Applicability

The research has generated outcomes on dynamics and aspects on a project level, and on the dynamics and elements within each aspect. All outcomes have been illustrated with quotations that help practitioners and researchers to translate the findings and conclusions to their own situation. Recommendations are provided that help managers to concretely develop each aspect in their own company, team or project. I therefore think that the results of the research are extremely applicable to other projects in practice, and may thus contribute to innovation and learning for greater sustainable development.

Summary

The evaluation above leads me to conclude that the research was performed from a sufficiently neutral perspective and that the method of data collection and storage has guaranteed data integrity. The data can be called authentic and valid, it can all be confirmed, and it is available for peer review. All steps in the research process are auditable. Because of its methodical nature, the outcomes of the research can be transferred to other situations, and the research has generated outcomes that are applicable in practice.

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Curriculum Vitae

Han van Kleef (1963, Deurne, The Netherlands) received his Master in Economics at Tilburg University in 1987. After having fulfilled his military service and taking a year off to travel in Asia, he went to work for IBM in The Netherlands in 1991. For eight years he successively worked in the fields of accounting, market research and quality management.

In 1995, he rekindled the keen interest in nature and the environment that he had developed in his youth. In the years 1995-1998, parallel to his work with IBM, he followed additional courses in environmental management and sustainable entrepreneurship, and fulfilled a number of internships. In 1999, he started to work as a consultant for IMSA, and from 2003 – 2005 he worked as a senior consultant with BMD, an environmental consultancy that serves small and medium-sized companies. Han started his doctorate research on innovation and sustainable development in 1999, fascinated as he was by the innovation possibilities of stakeholder dialogue projects that he had observed in a number of assignments.

In 2005, Han set up Trees Inventing, a consultancy firm specializing in innovation and sustainable entrepreneurship. The firm has done work for companies mainly in the metal, food, paper and board producing, and electronics sector, for educational institutions and for provincial and local governments. Trees Inventing specializes in advising and coaching teams and managers in multi-actor situations where improvement is desired on innovation in business processes and on social and environmental performance. Han also works as a freelance teacher in polytechnics in the subjects of Management and Organization and as an Assessor in in-company educational trajectories.

Han finds the combination of research, teaching and consultancy very fruitful, intellectually stimulating and satisfying, and intends to continue these activities in the future. He is married and has two children. In his spare time he enjoys long distance barefoot running, winter swimming and horse riding.

Appendices

Appendix I The research protocol

In this section, the research protocol is explained. I clarify the process of data gathering, the selection of the interviewees and the questionnaire that I used. I also explain how the data was gathered, stored and checked. Finally, I explain the process of translation of the quotations and evaluate the research method.

Data gathering

Data gathering was done through personal interviews with several managers and specialists in relevant functions in the selected companies. Data was also gathered from written, formal documentation on the companies and the projects. In each company, I introduced myself and explained the research, its set-up and goals. I then interviewed the company manager or director on the company, its competences and its innovations. Based on these interviews, in consultation with the company director or manager, I selected the innovation processes that I would research.

Selection of the interviewees

The interviewees were selected in an iterative process called snowball sampling. First, the director or operations manager of the company is interviewed. In this interview an inventory is made of the people who worked on the selected project. Also, the importance of their contributions is specified. All of the people who had key roles were then interviewed, and they were asked who else should be interviewed. Thus, a cross validation was achieved for the most important actors in the project. They were all interviewed, except for three people who were unable or unwilling to cooperate.

The questionnaire

A. Introduction to each interview

- Introduce Han van Kleef
- Introduce the research
- Introduce the structure of the interview: narrative interview, broad open questions, ask permission to tape-record, guaranteed anonymity

B. The first interview, with company management

1) To collect oral and documented information on the company and its history
   a) Can you tell me about the company?
   b) How would you describe the culture of the company?
   c) I am interested in the competences that contribute to the company's success - what in your view has contributed to the success of the company, in other words what does it do well?

2) To select the innovation to be researched: one that originates from market opportunities or competitive pressures
   a) Can you describe some recent innovations in the company and its products/services?
   b) That is an interesting list - what in your view are the characteristics of an innovation? How would you define the term?
   c) Could you give me some examples of innovations undertaken because of market opportunities?
   d) Could you give me some examples of innovations undertaken because of competitive pressure?
   e) Could you give me some examples of innovations undertaken because of other factors?

C. All other interviews with managers and specialists who were involved. These interviews are designed to collect information on:

3) The innovation and its development process
   a) Could you tell me about how the innovation process developed?

4) The company. Its organizational competences and their development.
   a) What role did the company organization (formal structures and systems, business processes and routines) play in structuring, promoting or inhibiting the innovation process?
   b) Are there any particular individuals who played a critical role in the innovation process? What was that role, in your opinion?
   c) Could you tell me about how the company manages the capabilities in relation to this innovation?

5) The network and its dynamics
   a) What actors were involved?
   b) Who were the most influential in terms of the final outcome and in what ways did they promote, inhibit or shape the outcome?

6) The team and its dynamics
   a) Could you tell me about the team?
   b) How was its composition decided upon?
   c) Who was in the team?
   d) Who were the most influential members in terms of the final outcome and in what ways did they promote, inhibit or shape the outcome?

7) The managerial capabilities and their development
   a) Could you tell me about your role in the innovation process? And what particular skills or capabilities did you bring to the innovation?
   b) How did you develop these skills/capabilities?

Capturing, storing and checking the data

I used a cassette recorder to capture the data on tape. This was permitted by all interviewees. I took notes to prevent the loss of data in case the cassette recorder did not function. Due to a mistake in one interview, I did not succeed in recording the interview and I had to rely on the notes. The recorded interviews were typed out in full. Then, for each case, data sheets were constructed. For each of the seven main questions in the questionnaire, one data sheet was made. Then, each sheet was filled with the answers from the interviewees related to that question. For each case, an elaborate case description was drawn up, drawn exclusively from exact and anonymized quotes from the interviews. The description of each case was sent to the central manager of the project, along with a request to check for factual errors and suggestions for improvements, and to indicate if the description was a fair representation of the project as the manager experienced it. Each of the reviewers contributed a few minor corrections. All the reviewers approved of the description as a correct representation of the project.

The use of quotations. Translation of the quotations

I have included many quotations from the interviews in the text. The reason for this is that I see them as concrete and authentic empirical proof of the findings. All interviews were done in Dutch, and the quotations were translated by a native English speaker who professionally translates scientific and other texts.

Appendix II Literature research

Table II.1 Managerial capabilities to be developed for an organizational competence in innovation for competitive reasons

	1. Capabilities to develop a system view of the innovation process	2. Capabilities for learning and developing	a. For employee, team and resource development	b. For cultural change	c. To develop new skills and knowledge, and to learn about the process of collaboration and innovation	d. To design an adequate organization, management, and new work practices	3. Capabilities to combine experimentation with optimization, exploration with exploitation, and to integrate knowledge and various kinds of innovations	a. To enable a continuously innovating company
Cooke and Wills (1999)								
Ritter and Gemunden (2003a)								
Nooteboom (2000a)					V	V	V	
Lundvall (1990, 1992)	V				V	V		
Edquist (1997)	V				V			
Utterback (1996)	V		V	V		V	V	
Hargadon and Sutton (2000)			V			V		
Hamel and Valikangas (2003)			V			V	V	V
Tushman and O'Reilly (1997); O'Reilly and Tushman (2004)			V	V		V	V	V
Foray, 1997	V				V			V
Doz et al. (1997)			V	V	V	V		
Volberda and Van den Bosch (2004)			V	V	V	V		
Brown (1997)			V		V	V		V
Tushman and Nadler (1996)			V	V	V	V		

b. To promote variety and combine existing knowledge			V		V		V	V		V				
4. Capabilities to find new options using hunches, imagination and intuition	V	V	V				V	V				V		
5. Networking capabilities														
a. To monitor the firm's external environment (for discontinuities, partners, competitors, ideas, etc.)	V		V	V	V	V	V	V	V	V	V			V
b. On all levels in the company, to facilitate collaboration and the integration of different perspectives, knowledge and information	V	V	V			V		V	V				V	
c. Social skills (e.g. communication ability, conflict management skills, empathy, emotional stability, self-reflectiveness, sense of justice, co-operativeness)	V	V			V								V	
d. Specialist skills	V			V									V	
e. Relationship management skills and activities	V	V		V									V	
6. Coalition building capabilities for co-production and collaboration (e.g. in alliances)	V	V		V	V			V		V	V	V	V	V

Table II.2 Managerial capabilities to be developed for an organizational competence in innovation that contributes to sustainable development

	1. Systemic thinking	2. Capabilities for learning and developing	a. To learn and translate learning into action, to deal effectively with the requirements, values, assumptions and cultures of various interacting network actors, to successfully understand and execute innovation activities with the network
Wynne (1995)			✓
Winter and Steger (1998)			✓
Dyllick et al., 2002			✓
Foster et al. (2000)			
Martens, Rotmans and De Groot (2003)	✓		
Shilling and Osha (2003)			
Jelsma (1995)			✓
Boons and Berends (2001)			✓
Hawk (1995)	✓		
Herbold (1995)			✓
Rip, Misa and Schot (1995)			✓
VROM-raad (2002)	✓		✓
Remmen (1995)			✓
Partidario and Vergragt (2002)			✓
Sweet, Roome and Sweet (2003)	✓		✓
Clarke and Roome (1995)	✓		✓
Roome [33, 36, 49]	✓		✓
Eur. Commission (2001)	✓		✓

3. Capabilities for integrating business, environmental and social problems, perspectives and information																		
a. To integrate the perspectives and knowledge of different actors in the network	V	V	V	V	V	V		V					V					
b. To integrate traditional criteria of efficiency with eco- and socio-efficiency and effectiveness	V	V					V	V						V		V		
4. Capabilities to develop alternative business models, methods and trajectories that are more synthetic, dynamic, and pragmatic, to enable radical or systemic innovation		V			V		V			V								
5. Networking and social capabilities																		
a. To develop social relations with (culturally) unfamiliar actors in- or outside the organization for information gathering, experimentation and negotiation	V	V	V	V	V	V			V	V	V	V			V		V	V
b. To create and cultivate broad, diverse, inclusive networks for learning to cope with uncertainty and for gathering information and diverse approaches from actors	V	V	V		V	V			V		V	V	V		V			
c. To build trust, a shared vision and agreement on basic values		V		V	V					V	V							
d. To involve local actors & initiatives	V	V				V			V				V	V				

6. Coalition and collaboration building capabilities																		
a. To promote joint action by many different (local) stakeholders, an open process of innovation and adaptation, building a shared vision, supporting collaboration and collective problem finding	V	V	V	V	V	V	V	V	V			V	V		V			
b. To integrate differences in information processing and decision styles, to deal with differences in the width of focus and the desired degree of maximization of the result				V														

Table II.3 Recommendations for further research identified in innovation and sustainable development literature reviews

RECOMMENDATIONS FOR FURTHER RESEARCH	INNOVATION LITERATURE REVIEWS				SUSTAINABLE DEVELOPMENT LITERATURE REVIEWS		
	Smith, Busi, Ball and Van der Meer (2008)	Frishammar, Kurkkio, Abrahamsson and Lichtenthaler (2012)	Schiederig, Tietze and Herstatt (2012)		Klewitz and Hansen (2011)	Van Huijstee, Francken and Leroy (2007)	Crutzen and Herzig (2012)
1. Empirical research	√	√				√	√
2. Dynamics							
(Learning) dynamics of different types of innovation processes		√					
The dynamic development over time and in practice		√					
3. Systems perspective							
Networking, collaboration, partnership contributions and (inter) organisational learning processes					√	√	

Linking different perspectives (actor – institutional) and aspects (ecological – economic – social) and integrating different innovation processes (product – process)		V				V	V
Multidisciplinary research. Integration of research disciplines. Integration of different kinds of innovation projects						V	V
4. Management: dynamic capabilities to transform process innovation. Managing innovation processes at micro-level		V	V				
5. Unique characteristics of SMEs with regard to sustainability oriented innovation					V		

Table II.4 Recommendations for further research identified in literature reviews and other articles in the field of organizational learning

	ORGANIZATIONAL LEARNING LITERATURE REVIEWS					OTHER ARTICLES RELATED TO ORGANIZATIONAL LEARNING								
RECOMMENDATIONS FOR FURTHER RESEARCH	Sambrook and Roberts (2005)	Karatas-Özkan and Murphy (2010)	Barker Scott (2011)	Haamann and Basten (2012)	Dasgupta and Gupta (2009)	Jiménez-Jiménez and Sanz-Valle (2011)	Garcia-Morales, Llorens-Montes and Verdú-Jover (2006)	Sanz-Valle, Naranko-Valencia, Jiménez-Jiménez and Perz-Caballero (2011)	Nooteboom (2006)	Yu (2011)	Alegre and Chiva (2008)	Siebenhuhner and Arnold (2007)	Müller and Siebenhüner (2007)	Argote and Miron-Spektor (2011)
1. Empirical research	V			V		V		V			V	V	V	
2. The dynamic development over time and in practice							V			V				
3. Understanding and managing group or team learning and (inter) organisational (sustainability) learning processes	V	V	V						V	V	V	V	V	
4. Complexity	V		V							V				

5. Systems perspective														
Linkages between the concepts			V					V						
Combination/integration of the aspects				V										
6. Reference to the importance to work with concrete practical business problems			V		V									
7. More effective sharing of knowledge		V		V										
8. The possible role of public policy in initiating sustainability-oriented organizational learning processes													V	
9. The conditions that promote the transformation of experience into knowledge														V

Table II.5 Recommendations for further research identified in literature on inter-organizational learning

	ARTICLES ON INTER-ORGANIZATIONAL LEARNING AND ….						
	… SUSTAIN-ABLE DEVELOP-MENT		… COM-PETENCE DEVELOPMENT	… RESEARCH OF PRACTICE	… COLLABORA-TION IN NETWORKS AND PROJECTS		
RECOMMENDATIONS FOR FURTHER RESEARCH	**Banyan (2010)**	**Siebenhüner and Heinrichs (2010)**	**Du Chatenier (2009)**	**Smith (2012)**	**Lampela (2009)**	**Rondeaux et al. (2009)**	**Westerlund and Rajala (2010)**
1. Explanatory factors of the dynamics and processes of inter-organizational learning							
Research to better understand and facilitate social and individual learning in relation to sustainable development		V					
What are the concepts, supportive tools, learning processes, influential factors and dynamic models related to interorganizational and network learning?					V		

Which contextual, processual or managerial conditions can exert an influence on the emergence of good network management practices?						V	
More longitudinal practice-based micro-level studies are needed to reveal explanatory aspects (in the fields of social interactions and innovation dynamics) of inter-organizational R&D collaboration				V			
2. Competence development							
What leadership competencies are needed to leverage resources to the mutual benefit of the organization and community?	V						
How to develop open innovation competence in professionals?			V				
3. Empirical testing							
Test the relationship: explorative learning orientation - product co-innovation - more networking; and the relationship: exploitative learning orientation - process innovation - less networking							V

Table II.6 Recommendations for further research identified in literature on dynamic capabilities

	ARTICLES ON DYNAMIC CAPABILITIES AND ...											
	... SUSTAINABLE DEVELOPMENT/ CSR				...RESEARCH AGENDAS				... LEARNING OR DEVELOPMENT			
RECOMMENDATIONS FOR FURTHER RESEARCH	**Ramachandran (2011)**	**Ednilson de Oliveira Cabral (2010)**	**Wu et al. (2012).**	**Castiaux (2012)**	**Wang and Ahmed (2007)**	**Easterby-Smith, Lyles and Peteraf (2009)**	**Di Stefano, Peteraf and Verona ((2010).**	**Barreto (2010)**	**Nooteboom (2009)**	**Harris, Kaeferand and Salchenberger (2013)**	**Narayanan and Douglas (2009).**	**Swift and Hwang (2008)**
1. Understanding of the relationships between dynamic capabilities and performance												
What are the relationships between capabilities, innovations types and sustainability outcomes?		V										
Do some kinds of dynamic capabilities lead to higher sustainable outcomes than other dynamic capabilities?		V										
What is the relationship between dynamic capabilities and performance?								V				

In which environments and firms is the concept of dynamic capabilities relevant?								V				
2. Understanding of the development of dynamic capabilities in relation to business processes												
What is the relationship between organizational and managerial processes (e.g. strategy process, IT, R&D and Marketing) in the development of a dynamic capability?						V	V			V	V	
How is economic activity organized and what is the location of firm boundaries (issues of governance)?							V					
What are the relationships between the propensities that make up dynamic capabilities and what are the influential factors?								V				
What are the linkages between firm-specific processes and the commonalities of dynamic capabilities across firms?					V							
2. Understanding of the development of dynamic capabilities in relation to change and transformation												
How can we explain the transition of organizations from a clear learning culture to one where learning is not valued?												V
What is the relation with strategic entrepreneurship and organizational transformation, the utilization of resources, the implementation of new processes, seeking out and taking advantage of new opportunities (related to themes of exploration and capability exploitation)						V						

How to develop and integrate these dynamic capabilities as an organization?				V								
How do firms develop and apply dynamic capabilities to address the distinctive challenges involved in corporate change toward sustainability?			V									
3. Understanding of the development of dynamic capabilities in relation to the role and contributions of managers												
What are the attributes and the involved human and social capital of integrative, collaborative processes that span departmental and organizational boundaries?	V						V					
What are the role and characteristics of facilitators and individual managers in organizational learning processes?							V					V
What are the links between dynamic capabilities and other micro-issues, such as managerial cognition and search processes?						V						
How do replicable managerial actions (in the early phases of capability development) accumulate to generate inimitable capability?											V	
4. Understanding of the development of dynamic capabilities in relation to other factors												
What is the relationship with growth, markets and alliances?							V					

Research on conceptual issues (e.g. distinguishing between operational and higher order capabilities; and between capabilities that rely on incremental learning processes and those that presuppose dramatic new knowledge trajectories)						V						
5. Empirical testing												
Empirical testing of dynamic capabilities on the level of individuals and organizations									V			
Empirical testing of the heuristic of invention to turn exploitation into exploration									V			
The study of successful and unsuccessful experiments in the development of dynamic capabilities to distill lessons for practising managers											V	
Empirical testing of the relationship between each aspect of the dynamic capabilities for corporate sustainability. Identify influential factors of effective deployment and the sources of these dynamic capabilities. Examine the validity of the conceptual framework and achieve more generalizable theoretical findings.			V									
Research needs to investigate processes of creation and evolution over time, which points to the need for more longitudinal studies.						V						
Include more traditional ['non-dynamic'] industries, the public sector and other countries						V						